April 8, 1998 DRAFT

C&SF RESTUDY ALTERNATIVE EVALUATION TEAM REPORT ON THE PLAN FORMULATION ALTERNATIVE 4

Prepared by the C&SF Restudy Alternative Evaluation Team

Introduction

The Central and Southern Florida (C&SF) Project Restudy created an Alternative Evaluation Team (AET) for the purpose of evaluating the effects from a number of alternative plans, as a basis for developing the Comprehensive Plan for the C&SF Project. The objective of the AET evaluation process is to identify the plan (or plans) which best meets the regional restoration and sustainability goals set by the authorizing legislation for the C&SF Project, and the Conceptual Plan of the Governor's Commission for a Sustainable South Florida. The optimum components in a Comprehensive Plan are identified by means of an iterative evaluation process, whereby different combinations of these components are sequentially modeled and evaluated relative to a set of pre-determined performance measures. Components which substantially improve on base conditions, or which meet performance targets, are carried forward in the iterative modeling and evaluation process, while components which fail to perform well may be modified or rejected.

The AET is an ad hoc team, established by the Restudy for the specific purpose of evaluating a large number of alternative plans during a definitive planning process. The plan evaluation process is scheduled for September 1997 through April 1998. This report presents a summary of the conclusions of the fourth plan evaluation meeting of the AET, held March 5-6, 1998. At this meeting, the AET evaluated the Alternative 4 model simulation (summarized below). The core of this report is a set of evaluations conducted by ten subregional and issue subteams of the AET, relative to Alternative 4, and recommendations from these subteams and the full AET for improvements in performance required during subsequent plan simulations. This report also includes recommendations for improvements in the plan evaluation process, for incorporation in future evaluation cycles.

Methods

The AET is a multi-agency, multi-disciplinary team, consisting of about 30 members. The AET is divided into ten subregional and issue subteams, each with a chair or co-chairs (Kissimmee / Lake Okeechobee, Lake Okeechobee Service Area, Lower East Coast, Northern / Central Everglades, Southern Everglades, Estuaries and Bays, Big Cypress, Total Systems, ATLSS / Threatened and Endangered / Keystone Species, and

Water Quality). During each evaluation cycle, each subteam has the lead responsibility for collecting all evaluations submitted to the AET from any non-AET source, which are applicable to the subregion and issues being addressed by that team; additionally, each subteam performs its own evaluations. The subteams synthesize all evaluations into subteam reports to the full AET during each evaluation cycle.

Plan evaluations conducted by the subteams and the full AET are based on, (1) a set of pre-determined, hydrological performance measures, and (2) output from landscape-scale, ecological and water quality models. Each performance measure identifies specific hydrological targets, based on ecological, water supply, flood control and water quality objectives established for the C&SF Restudy. These hydrological targets have been defined in large part through the development of a suite of conceptual ecological models for the south Florida wetland landscapes, the draft Lower East Coast Regional Water Supply Plan, and the Lake Okeechobee Regulation Schedule Study. Performance measures may be added or deleted from the set used by the AET, based on recommendations from the subteams and approval by the full AET. Each alternative plan is evaluated based on the success of that plan in meeting the targets established by the performance measures. The hydrological performance of each plan is reported on the public web site during each evaluation cycle.

In addition to the performance measures, the AET may use output from four landscape scale models, the Across Trophic Level System Simulation model (ATLSS), the Everglades Landscape Model (ELM), the Everglades Water Quality Model (EWQM), and the Lake Okeechobee Water Quality Model (LOWQM). These models will be used to compare effects from alternative plans against either the current base (1995) or future "without project" base (2050). Summaries of output from these models, as it becomes available to the AET, will be reported in the AET evaluation reports.

Evaluations submitted by a subteam to the full AET, whether originating from the subteam or from an outside evaluator, are framed within the context of one or more performance measures. The full AET, during its meeting, synthesizes the subteam evaluations into a set of summary, "highlights" statements. These highlights statements are intended to describe the major strengths and weaknesses of the plan under current review, relative to the targets set by the performance measures. The highlights statements are provided to the Alternative Development Team (ADT) as a basis for designing the next alternative plan.

In addition to the highlights report, the AET prepares a written report of each evaluation cycle. The written reports include short narrative summaries from each subteam, a list of the performance measures used by the subteams during that evaluation cycle, and recommendations for future plans and to the evaluation process.

Evaluation of Alternative 4

Plan Components

The following components are those which were included in the Alternative 3 hydrologic simulation by the South Florida Water Management Model (SFWMM). A more detailed description of the alternative can be found on the Restudy web site (www.restudy.org), Comprehensive Plan Evaluation, Alternatives Description / Evaluation.

Component A4. A Storage Reservoir (20,000 acres at 10' maximum depth) north of Lake Okeechobee.

Component B2. A Storage Reservoir (10,000 acres at 4' maximum depth) in the St. Lucie basin.

Component C1. Environmental Water Supply Deliveries to the St. Lucie Estuary (operational change only).

Component D3. A Storage Reservoir (20,000 acres at 8' maximum depth) with Aquifer Storage and Recovery (22 10-MGD wells) in the Caloosahatchee basin.

Component E1. Environmental Water Supply Deliveries to the Caloosahatchee Estuary (operational change only).

Component F3. Current Lake Okeechobee Regulation Schedule (with the exception of all but Zone A [emergency] regulatory releases to the St. Lucie Estuary).

Component G3. A Storage Reservoir (one 40,000 acre compartment at 6' maximum depth for supplying environmental demands and one 20,000 acre compartment at 6' maximum depth for supplying EAA irrigation demands) in the Everglades Agricultural Area with increased conveyance from Lake Okeechobee to the reservoir.

Component H4. Everglades Rain-Driven Operations (Draft Lower East Coast Regional Water Supply Plan Alternative 5 Operational Rules for deliveries to the Water Conservation Areas and Everglades National Park with the addition of triggers for Northeast Shark River Slough).

Component I3. Not included in Alternative 4.

Component J. Not included in Alternative 2, 3 or 4.

Component K4. Water Preserve Areas / L-8 Project Phase II in northern Palm Beach County – modified to capture additional water with aquifer storage and recovery (25-MGD capacity well clusters at Lake Mangonia) and improve stages in the West Palm Beach Water Catchment Area.

Component L3. Change Coastal Wellfield Operations in the Lower East Coast Service Area.

Component M4. Water Preserve Areas / Site 1 (1,660 acre at 6' maximum depth) with Aquifer Storage and Recovery (15 5-MGD wells) in western Palm Beach County.

Component N2. Not included in Alternative 4.

Component O4. Water Conservation Area 3A and 3B Levee Seepage Management in Broward County.

Component P2. Not included in Alternative 4.

Component Q4. Water Preserve Areas / Western C-11 Diversion Canal (1,600 acres of stormwater treatment area / impoundment and 2,500 cfs diversion canal) in Broward County.

Component R4. Water Preserve Areas / C-9 Impoundment (2,500 acres at 4' maximum depth) in Broward County.

Component S4. Central Lake Belt In-ground Storage Reservoir (5,200 acres) in Dade County.

Component T1. C-4 Structure in Dade County.

Component U4. Water Preserve Areas / Bird Drive Impoundment (2,877 acre at 4' maximum depth) in Dade County with operational rules for the C-4 downstream diversion structure.

Component V2. L-31N Levee Improvements for Seepage Management in Dade County with additional reduction of seepage in the wet season.

Component W2. Taylor Creek / Nubbin Slough Storage and Treatment Area (5,000 acre storage area at 10' maximum depth and 5,000 acre stormwater treatment area at 4' maximum depth).

Component X3. Water Preserve Areas / C-17 Backpumping in North Palm Beach Service Area (550 acre stormwater treatment area at 4' maximum depth).

Component Y3. Water Preserve Areas / C-51 Backpumping to Water Catchment Area in Palm Beach County (600 acre stormwater treatment area at 4' maximum depth).

Component AA3. Additional S-345 Structures in L-67A in Water Conservation Area 3B.

Component BB4. Improvement to Dade-Broward Levee and to reduce seepage from the Pennsuco wetlands and WCA-3B.

Component CC3. Broward County Secondary Canal System (increase pump capacity and canal conveyance in C-12 and C-13).

Component DD3. Revised Holey Land Operational Plan (based on rain-driven operations) in Palm Beach County.

Component EE3. Modified Rotenberger Regulation Schedule (based on rain-driven operations) in Palm Beach County.

Component FF4. Construction of S-356 A & B Structures and relocation of a portion of L-31N in Miami-Dade County.

Component GG4. Lake Okeechobee Aquifer Storage and Recovery (100 10-MGD wells) along the lake peripheral levee.

Component HH3. Not included in Alternative 4.

Component II3. Pump Station G-404 Modification in Palm Beach County.

Component JJ3. Not included in Alternative 4.

Component KK4. Loxahatchee National Wildlife Refuge Internal Canal Structures to improve timing and location of water depths in the Refuge in Palm Beach County.

Component LL4. C-51 Regional Groundwater Aquifer Storage and Recovery (54 well clusters 170-MGD total capacity) in Palm Beach County.

Component MM4. Hillsboro Canal Basin Regional Aquifer Storage and Recovery (22 well clusters 110-MGD total capacity) in Broward and Palm Beach counties.

Component NN3. Not included in Alternative 4.

Component OO4. Reduce Wet Season Flows to South Dade in Southern Portion of L-31N and C-111 to increase deliveries to Northeast Shark River Slough in Miami-Dade County.

Component PP3. Not included in Alternative 4.

Component QQ4. Decompartmentalization of WCA-3 to remove flow obstructions and reestablish ecologic and hydrologic connections in Broward and Miami-Dade counties.

Component RR4. Flow to Central WCA-3A by relocating the S-140 pump station in Broward County.

Component SS4. Reroute Miami-Dade County Water Supply Deliveries to the North New River Canal due to backfilling the Miami Canal in Broward and Miami-Dade counties.

Component TT4. Not included in Alternative 4.

Component UU4. Storage Reservoir (16,500 acres at 10" maximum depth) in Martin and St. Lucie counties for flood attenuation to the estuary and water supply benefits.

Component VV4. Agricultural Reserve Reservoir (1,660 acres at 6' maximum depth) in Palm Beach County to increase regional water resources.

Component WW4. C-111N Spreader Canal in Miami-Dade County to reduce wet season flows in C-111.

Component XX4. North Lake Belt Storage Area (3,500 acres with subterranean seepage barrier) in Miami-Dade County to increase regional water resources.

Component YY4. Divert WCA-2 Flows to Central lake Belt Storage in Broward and Miami-Dade counties to capture excess water in WCA-2B.

Alternative 4 Highlights

The following highlights represent the major strengths and weaknesses of Alternative 4, as evaluated by the AET:

AET TOP 10 LIST FOR ADT TO ADDRESS

1. Biscayne Bay: Needs more water.

2. WCA-2A/B/Central Lake Belt storage:
   a. reduce frequency of extreme high water events in southern WCA-2A
   b. reduce frequency of drydowns in 2B
   c. maximize capacity of central lakebelt reservoir (storage/conveyance)
   d. fill reservoir by January by diverting flow Sept-Dec
   e. deliver reservoir water to Northeast Shark River Slough, using Rocky Glades trigger, beginning in January

f. deliver reservoir water to Dade/Broward levee canal, south Dade wetland system, and Biscayne Bay starting January.

3. WCA-3: Decrease frequency of high and low water events in eastern WCA-3A and WCA-3B.

4. Decompartmentalize Everglades Protection Area and consider passive conveyance/operations.

5. Lake Okeechobee: Prevent lake from dropping to low levels, to decrease frequency of lake-triggered water shortages in Lake Okeechobee Service Area and Lower East Coast Service Areas, and to decrease frequency of ecologically damaging low water levels.

6. Minimize use of aquifer storage and recovery (ASR). Create additional storage in Lower East Coast.

7. Holey Land/Rotenberger: Change operations to reduce amplitude of water fluctuations. Tie into additional storage.

8. Big Cypress: Prevent extreme drainage in NE Big Cypress using alterations recommended by design group.

9. Capture more water into the regional system (focus on looking at the Caloosahatchee, St. Lucie canal, put more ASR in coastal Palm Beach County, and back off on Lake Okeechobee ASR).

10. Spread out Everglades Agricultural Area (EAA) storage and use it more frequently, add area on L-8 (will that make storage north of the lake expendable?).

A. TOTAL SYSTEM

Performance Indicator: Mean Annual Overland Flow.
Goal/Target: Restore general overland flow patterns**.**
Performance: The natural environment has been compartmentalized and flow patterns severely altered by the C&SF Project. Generally, in comparison to Alternative 3, Alternative 4 improves flow patterns through the WCA-3A (south), WCA-3B and Everglades National Park. Velocities along the eastern boundary and through Shark River Slough are much greater than are indicated under natural conditions.
Improvement Needed: Additional improvements are needed, particularly in patterns through WCA-2A, WCA-2B and Loxahatchee National Wildlife Refuge, and velocities through Shark River Slough.

Performance Indicator: Hydroperiod Distribution.
Goal/Target: The general goal is to match NSM patterns.

Performance: The NSM for the dry year 1989 indicates the persistence of several long-hydroperiod areas connected by intermediate hydroperiod class wetlands. Alternative 4 shows a more chopped up pattern: a large pool persists in WCA-3A during 1989, and a large pool (hydroperiod of 240-300 days, 300-330 days, and 330-365 days) in Loxahatchee National Wildlife Refuge. Areas of WCA-2A also stay wet longer than conditions indicated by the NSM. In contrast, WCA-2B is dryer. Everglades National Park is also too dry during '89 in Alternative 4; Shark River Slough dries out (hydroperiod classes are mostly 240-300 days with some 300-330 days), and almost all of the hydroperiods in the Everglades National Park are shorter than NSM. During a wet year (1995) Alternative 4 more closely matches NSM. There are a couple of cells in WCA-2B that are drier than NSM. A couple of cells in Hole in the Donut are drier, but several nearby cells within Everglades National Park (ENP) are wetter than NSM. The Model Lands are also wetter than NSM.
Improvement Needed: Continue improvements made in dry year pools and patterns. Continue improvements to long hydroperiod areas, including the long hydroperiod sloughs (particularly Shark River Slough) in ENP.

Performance Indicator: Hydroperiod Improvement.
Goal/Target: Minimize acreages with too short or too long hydroperiods.
Performance: Hydroperiod Differences Relative to NSM: for Alternative 4, the dry year (1989) modeled was dryer for the following areas - most of WCA-2B was 90-180 and 180-365 days drier; much of WCA-3B was also dry during '89. Shark River Slough hydroperiods were on average 30-60 days shorter. Rocky Glades hydroperiods were 60-90 days and 90-180 days shorter. Some areas in the Model Lands show longer hydroperiods. Also, a few grids in ENP show hydroperiods 30-60 and 60-120 days longer. Hydroperiod Differences Relative to 2050: limited improvements (hydroperiods are moving in the direction of NSM) to remaining natural areas (535,040 acres); however, 215K acres were too dry, 281K acres didn't change, and 376K acres overshot NSM conditions.
Improvement Needed: Some improvements to ENP overall but the sloughs could still use longer hydroperiods. Unless areas will serve as dry season pools, hydroperiods should be reduced in areas where water is pooling.

Performance Indicator: Ponding Depth and Depth Differences map and histograms.
Goal/Target: General NSM depths patterns.
Performance: Alternative 4 ponding depths oscillate between extreme highs during wet periods to extreme lows during dry periods. This results in ponding averages looking pretty good when in fact they are not. Need more moderation in ponding depths. WCA-2B is particularly adversely effected by high and low ponding depths. Refer to the weekly stages for indicator region # 23. Also, the hydroperiod performance indicator reflects this.
Improvement needed: Lower water elevations in WCA-2B. Even if a long hydroperiod could make it a suitable dry year refuge, depths are excessive.

B. KISSIMMEE/LAKE OKEECHOBEE SUBREGION

Performance Measure: Number of stage events >17 ft.
Target: No events.
Comments: Alternative 4 reduced the number of events to two.
Recommendation: Maintain this benefit to the lake.

Performance Measure: Number of stage events >15 ft lasting > 6 months.
Target: No events.
Comments: Alternative 4 reduced the number of events to two, and had a median duration that was well below six months, and considerably lower than Alternative 3.
Recommendation: Maintain this benefit to the lake.

Performance Measure: Number of stage events <12 ft lasting >6 months.
Target: No events.
Comments: Alternative 4 increased the number of events to six, as compared to Alternative 3 (five events). The duration of <12 ft events was considerably longer under Alternative 4 than Alternative 3.
Recommendation: Reduce the frequency and duration of <12 ft events.

Performance measure: Number of stage events <11 ft.
Target: No events.
Comments: Alternative 4 increased the number of events to eight, as compared to only six events with Alternative 3. Despite a greater number of events in Alternative 4, the median duration is very short relative to all other events.
Recommendation: Reduce the frequency of <11 ft events.

C. LAKE OKEECHOBEE SERVICE AREA

Performance Measure: Frequency of Water Restrictions for the 1965 – 1995 Simulation Period Lake Okeechobee Service Area.
Goal: Total number of water restrictions events (years with restrictions) should be three or less in the simulation period to indicate that the goal of meeting demands in a 1-in-10 year drought is being met.
Performance: Years with water restrictions were ten in the 1995 base and increased to 15 in the 2050 base. They were only reduced by three events to 12 in Alternative 2. In Alternative 3 they were reduced another four events to eight. In Alternative 4 they increase to 11. One of the events lasts nine months, which is longer than the target maximum duration of seven months.
Improvement Needed: The number of water years with restrictions needs to be reduced from 11 to three. No event should be longer than seven months.

Performance Measure: EAA Water Budget (Runoff Backpumped to Lake Okeechobee).
Goal: Maintain existing levels of flood protection. Backpumping to Lake Okeechobee occurs only when flood waters reach threatening levels. Maintenance or reduction of backpumping indicates flood protection is being maintained. A more discerning performance measure is still being developed.

Performance: There is no indicated problem. Backpumping in Alternative 4 is less than in the 1995 base and is very, very low.
Improvement Needed: None.

D. LOWER EAST COAST

WATER SUPPLY:
Performance Measure: Frequency and Severity of Water Restriction Triggers for the 1965-1995 Simulation Period for North Palm Beach Service Area.
Goal: Reduce the frequency of local and Lake Okeechobee water restriction events to no more than three events for the 31-year period of record to meet a 1 in 10 level of certainty.
Performance: There are no locally triggered events in this service area. The frequency of Lake Okeechobee shortage events are too high, six events for the period of record.
Improvement needed: Reduce number Lake Okeechobee triggered cutbacks to a 1 in 10 level of certainty (no more than three events for period of record).
Recommendation: Deliveries to the environment could be reduced in order to ensure adequate levels are maintained in Lake Okeechobee to minimize the high number of water supply cutbacks to the Lower East Coast Service Areas.

Performance Measure: Frequency and Severity of Water Restriction Triggers for the 1965-1995 Simulation Period for Service Area 1.
Goal: Reduce the frequency Lake Okeechobee water restriction events to meet a 1 in 10 level of certainty (no more than three events for the 31-year period of record).
Performance: The alternative performs well since there is only one shortage event for the period of record caused by local trigger wells. The frequency of cutback events caused by Lake Okeechobee is still too high, six events occur for the period of record, all exceeding four months in duration.
Improvement needed: Reduce the number of Lake Okeechobee triggered cutbacks to a 1 in 10 level of certainty (no more than three events for the period of record).
Recommendation: Deliveries to the environment could be reduced in order to ensure adequate levels are maintained in Lake Okeechobee to minimize the high number of water supply cutbacks to the Lower East Coast Service Areas.

Performance Measure: Frequency and Severity of Water Restriction Triggers for the 1965-1995 Simulation Period for Service Area 2.
Goal: Reduce the frequency of local and Lake Okeechobee water restriction events to meet a 1 in 10 level of certainty (no more than three events for the 31-year period of record).
Performance: Nine shortage events for the period of record are caused by local trigger wells. The frequency of events caused by Lake Okeechobee increases in Alternative 4 when compared to Alternative 3. There are six cutbacks due to Lake Okeechobee levels. Pompano, Hollywood, Ft Lauderdale Airport, and North Lauderdale are causing the cutbacks. Hollywood and Ft Lauderdale Airport are the most problematic. Moving Hollywood's pumpages has helped reduce the number of local events, but has not solved the problem of low ground water levels in the C-10 basin.

Improvement needed: Reduce number of local ground water and Lake Okeechobee triggered cutbacks to a 1 in 10 level of certainty (no more than three events for the period of record).
Recommendation: Moving water east on the C-9 and connecting it to the regional system has helped and should continue. There may be another use for the water in C-9. Water could be routed from the C-9 basin north to Hollywood's wellfield to augment recharge. The pumpage should return to the eastern wellfields as in Alternative 3. A map will be provided. In addition, since the volume pumped does not seem to impact the number of locally triggered cutbacks, other causes of low ground water levels should be determined and modified to alleviate the number of cutbacks in this basin. Deliveries to the environment could be reduced in order to ensure adequate levels are maintained in Lake Okeechobee to minimize the high number of water supply cutbacks to the Lower East Coast Service Areas.

Performance Measure: Frequency and Severity of Water Restriction Triggers for the 1965-1995 Simulation Period for Service Area 3.
Goal: Reduce the frequency of local and Lake Okeechobee water restriction events to meet a 1 in 10 level of certainty (no more than three events for the 31-year period of record).
Performance: Seven shortage events for the period of record are caused by local trigger wells. The wells causing problems in Service Area 3 are to Homestead (12 times), Florida City (one time – Phase 2), and Taylor (six times). Alternative 4 has reduced the cutbacks to Cutler Ridge, North Miami, and Miami to zero. It should be noted that the trigger that encompasses Florida City also includes the Florida Keys Aqueduct Authority and the South Dade Water Supply System. All of the Keys and South Dade would incur a phase 2 restriction. In addition, there are six Phase 1 Lake Okeechobee triggered events for Service Area 3.
Improvement needed: Reduce the number of local ground water and Lake Okeechobee triggered cutbacks to a 1 in 10 level of certainty (no more than three events for the period of record).
Recommendation: Additional mounding of ground water or increasing ground water seepage for Miami-Dade County would help. Deliveries to the environment could be reduced in order to ensure adequate levels are maintained in Lake Okeechobee to minimize the high number of water supply cutbacks to the Lower East Coast Service Areas.

CANAL LEVELS:
Performance Measure: % of time Canal Stage less than Saltwater intrusion Criteria and Occurrences greater than one Week for North Palm Beach Service Area.
Goal: Reduce amount of time and number of occurrences the canal does not meet saltwater intrusion criteria to zero.
Performance: All canal levels meet or exceed the saltwater intrusion criteria.

Performance Measure: % of time Canal Stage less than Saltwater intrusion Criteria and Occurrences greater than one Week for Service Area 1.

Goal: Reduce amount of time and number of occurrences the canal does not meet saltwater intrusion criteria to zero.
Performance: All canal levels meet or exceed the saltwater intrusion criteria.

Performance Measure: % of time Canal Stage less than Saltwater intrusion Criteria and Occurrences greater than one Week for Service Area 2.
Goal: Reduce amount of time and number of occurrences the canal does not meet saltwater intrusion criteria to zero.
Performance: The C-9 and C-14 canals do not meet the goal. The C-14 and the C-9 experience only a few low water levels that fall below the saltwater intrusion criteria (2% of the time). This is a significant improvement for the C-9 relative to previous alternatives.
Improvement Needed: Increase water deliveries during dry season to meet saltwater intrusion criteria in C-9 and C-14 canals or increase ground water seepage.
Recommendation: Alternative 4 results in higher stages at S-29 over much of the wet season and a noticeable decrease in the number of saltwater intrusion trigger events relative to Alternative 3. This implies that ground water levels are slightly higher, on average, than in Alternative 3, a result that is depicted in the stage duration curves for Indicator Region 48. These results indicate that there is a slightly greater hydraulic head for this alternative that should result in slightly improved ground water deliveries to Biscayne Bay relative to Alternative 3. Additionally, the ground water stage duration curves indicate that Alternative 4 results in higher ground water stages at the very low end of the curve, which implies that ground water flows to the bay may continue to a greater degree during drought conditions under this alternative. Alternative 4 therefore shows some improvement over Alternative 3 with respect to ground water conditions in Biscayne Bay. The stage duration curves for S-29 also show that 1995 Base and 2050 Base conditions resulted in higher canal stages than Alternative 4 approximately 25-30% of the year. Because ground water level is related to the hydraulic head, which would drive ground water flows to Biscayne Bay, improvements in total annual ground water flows to the bay might be achieved if these higher canal stages could be duplicated or exceeded in future alternatives without triggering flood events in that basin.

Performance Indicators: Mean wet/dry Season Flows to Pond Apple Slough through C-11@S-13 for the 31-year simulation. Stage duration curve for C-11 @S-13A. Mean wet/dry season flows to tide through S-13A.
Goal: Provide enough water to prevent saltwater intrusion of Pond Apple Slough. Flows should be greater than 1995 Base flows and flows should be greater in the wet season.
Performance: Flows over S-13 and S-13A are reduced by half and to zero, respectively, diminishing the water supplied to the Pond Apple Sough. Rehydration of the Slough is joint project by the SFWMD and Broward County - DNRP. In addition, the stage duration curve at S-13A indicates that the canal water levels drop very low. Flows over the S-13A drop from 48,000 acre/ft per year in the 1995 and 2050 Base to 0 in Alternatives 3 and 4.
Improvement Needed: More flows need to be sent east in C-11 to the Slough.
Recommendation: Modify operation of the C-11 Reservoir to provide more flows east. Perhaps component Q4 could be modified so that when storage is not available in the

Central Lake Belt Storage Area flows are sent east to Pond Apple Slough (S-13). Or water may be able to be routed from the North New River Canal south through the Flamingo Canal to the C-11.

Performance Indicator: Mean wet/dry Season Flows to North Fork of New River C-12@S-33 for the 31-year simulation.
Goal: Provide enough water to prevent saltwater intrusion of the North Fork of the New River. Flows should be greater than 1995 Base flows and flows should be greater in the wet season.
Performance: Flows over S-33 remain constant on all runs. It has been documented by Broward County DNRP that additional flows are necessary to prevent saltwater intrusion. Restoration of the North Fork of the New River is a Critical Project of the Corps and is sponsored by Broward County DNRP.
Improvement Needed: More flows needed to be sent east or operational criteria changed on C-12 to supply more water to the North Fork of the New River.
Recommendation: Provide more flows east or change operation criteria for C-12.

Performance Measure: % of Time Canal Stage < Saltwater Intrusion Criteria and Occurrences >1 Week - Canal C-6 at S-26, C-4 @S-25B, and C-2@S-22.
Goal: Reduce the amount of time and number of occurrences the canal does not meet saltwater intrusion criteria to zero.
Performance: Alternative 4 shows a significant decrease in the number of saltwater intrusion trigger events relative to Alternative 3 for the C-6, C-4 and C-2. The canals fail to meet the saltwater intrusion criteria only 1%-2% of the time. This is a great improvement over previous alternatives, which had the C-4 and C-2 failing to meet the criteria 27% and 21% of the time (Alternative 3). Even though Alternative 4 results in similar stages at S-22 over much of the wet season and a noticeable decrease in the number of saltwater intrusion trigger events during the dry season relative to Alternative 3, the stages are lower than either the 1995 Base or 2050 Base 75% of the time. Since canal stages are related to ground water levels on adjacent lands, this implies that the alternatives create lowered ground water levels relative to base conditions in this region, except under extreme dry conditions, where Alternative 4 results in higher canal stages to manage for saltwater intrusion.
Improvement needed: Reduce the percentage of time canals fails to meet saltwater intrusion criteria to zero.
Recommendation: Increase ground water flows.

Performance Indicator: Stage duration curves for C-100A, C-100B, C-102N, C-103, C-103S, C-102, and C-1.
Performance: Many of the South Miami-Dade County Canals water levels have shown some improvement in Alternative 4. C -100A may have an error in it since it shows canal levels over 16' NGVD. C-103 water levels have declined with respect to the 1995 Base. C-1, C-100B, C-102N, and C-103S have shown some improvement with respect to 1995 Base. Alternative 4 results in ground water stages that are not noticeably different from Alternative 3 or the 2050 Base, except under extreme dry conditions, but they are less than the 1995 Base under all conditions. The stage duration curves S-103 @ S-20F show

a similar relationship, but Alternative 4 results in slightly higher canal stages than either Alternative 3 or the 2050 Base. The lack of water supply to these canals may also result in the triggering of water shortages in South Miami-Dade. The backfilling of portions of the C-111 may have helped nearby canals.
Improvement needed: Meet or exceed the 1995 Base. Restore wet season flows.

RESERVOIRS:
Performance Indicator: Stage duration curves for the C-11 Reservoir.
Performance: Performs the same as in Alternative 3 & 2.
Recommendation: Send more water east to Pond Apple Slough.

Performance Indicator: Stage duration curves for C-9 Reservoir.
Performance: The reservoir is much drier when compared to Alternative 3.
Recommendation: Need to determine if water levels are adequate to protect existing wetlands.

Performance Indicator: Stage duration curves for North Lakebelt Reservoir.
Performance: The reservoir operates very well. The stage duration curve is high most of the time and it is able to supply water to meet saltwater intrusion criteria on the C-9.
Recommendation: Send additional supplies east, route to Hollywood wellfield and recharge it. This wellfield continues to be problematic despite moving wellfields inland.

Performance Indicator: Stage duration curves for Bird Drive Reservoir.
Performance: Operation of this impoundment needs to be reexamined and/or more water needs to be routed from the regional system to hold consistently higher levels in these canals. The stage duration curve exceeds ground elevation only 3% of the time, which is less often than Alternative 3. Water quality concerns have been addressed by directing flows from urban areas away from the reservoir.
Improvement Needed: Need to determine if component is effective.

Performance Indicator: Stage duration curves for Central Lakebelt Reservoir.
Performance: The Central Lakebelt Storage described in Alternative 4 has too many demands on it. The majority of the water is received from WCA seepage control and is pumped to NESRS. Using the water to meet natural area demands is inefficient because the improvement to the slough is minimal, which is due to the limits of the quantity of water stored in the reservoir.
Improvement Needed: Need to correct how component operates so more water is stored in the reservoir to meet local demands.
Recommendation: A more efficient use of the water would be to use it to maintain stages in the Dade-Broward Levee Canal, enhance supplies to the South Dade Conveyance System or improve dry season flows to Biscayne Bay. Flows to NESRS should come directly from WCA-2B and not be stored in the Central Lakebelt Reservoir.
Note: A new Miami-Dade County wellfield has been included in these alternative runs in southwest Miami-Dade, and the location of this wellfield needs to be identified with performance indicators run for it. Also note that Everglades National Park actually lost more ground water and levee seepage to the LEC in Alternative 4 than in Alternative 3.

DISCHARGES TO TIDE:
Performance Indicator: Mean Annual Surface Flows Discharge to Tide from the Lower East Coast Service Areas for the simulation period.
Performance: For Alternative 4, there is a trend from north to south of decreasing discharges to tide but saltwater intrusion criteria is still able to be met for the vast majority of the time. Discharges to tide in the North Palm Beach Service Area remain constant when compared to the 1995 Base. For Service Area 1, there is a 49% average annual decrease (399k acre-feet/yr) in discharges to tide when compared to the 1995. For Service Area 2, discharges to tide decrease approximately by 16% (75k acre-feet/yr) on average compared to the 1995 Base. In the case of Service Area 3, there is a 52% decrease in discharges to tide on average (525k acre-feet/yr) when compared to the 1995 Base. The total reduction in discharges to tide on an annual average is 1,016,000 ac/ft.

WATER DELIVERIES:
Performance Indicator: Average Annual Regional Water Supply Deliveries to Lower East Coast Service Areas for the period of record and for the five drought years.
Performance: The volume of water supplied on average has increased when compared to the 1995 Base, 2050 Base and Alternative 3 for Service Area 1 by up to 60%, increases for Service Area 2 by 200%, and increases for Service Area 3 by approximately 30%. Much of the increase in deliveries is due to increased reliance on aquifer storage and recovery (ASR) to supply water. There is some concern over the viability of this option when uncertainty surrounds its use. A different source of water should be found or the WCAs should be used to supply water. Exceeding the NSM targets for many of the cells in Everglades National Park indicate that there is water available in the regional system that could be used instead of water from ASR wells. During drought events, deliveries have declined for Alternatives 3 and 4 when compared to Alternative 2, the 1995 Base and 2050 Base. Much of the increase in deliveries is due to the use of ASR in Service Area 1. During wet years, the service areas have gained some self-sufficiency, but they are still dependent on the regional system during drought events. Maintaining the storage areas in the regional system is the key to overcoming droughts in the Lower East Coast Service Areas.
Improvement Needed: Reduce number of local ground water and Lake Okeechobee triggered cutbacks to a 1 in 10 level of certainty (no more than three events for the period of record).
Recommendations: Reduce dependence on ASR and maintain other storage areas in regional system.

E. NORTHERN AND CENTRAL EVERGLADES

HOLEY LAND WILDLIFE MANAGEMENT AREA:
Performance Measure: Inundation Duration (Indicator Region29).
Planning Targets: Match NSM #, mean duration and % of time.
☺ **Evaluation**: Alternative 4 is a good match for NSM on all three measures. This is a large improvement over the 2050 Base, but differs little from the 1995 Base or Alternative 3.

Performance Measure: Timing of Depth Variations. (Indicator Region 29).
Planning Targets: Match NSM timing of peaks and pattern of variability.
☺ **Evaluation**: Alternative 4 timing and seasonal depth pattern matches NSM; this is similar to Alternative 3, 1995 Base, and 2050 Base. Alternative 4 and Alternative 3 standard deviations are more similar to NSM than the 1995 or 2050 Bases

Performance Measure: Extreme High Water. (Indicator Region 29).
Planning Targets: (1) Minimize and (2) be less than or equal to NSM for each of three scores: # events; mean duration; and % of time > 1.5 ft depth.
☹**Performance**: Alternative 4 exceeds 1.5 ft 24 times, averaging 11 week's duration and 17% of total time. This is identical to Alternative 3, worse than 1995 Base (5% of time), but much better than 2050 Base (38% of time). Such high water is likely to promote cattail proliferation.

Performance Measure: Extreme Low Water (Indicator Region29).
Planning Target: (1) minimize and (2) be less than or equal to NSM for each of three scores: # events; mean duration; and % of time < -1.0 ft depth.
☹**Performance**: Alternative 4 dries out below –1.0 ft on ten occasions averaging four weeks duration; this is similar to 1995 Base (11 events) and 2050 Base (nine events) and slightly improved over Alternative 3 (13 events). Performance meets NSM targets but not soil protection targets.
Improvements needed: Overall, Alternative 4 (like Alternative 3) spends 20% of time in either high or low water conditions. There is a need to reduce high water events substantially without increasing the frequency of low water events. Hydroperiod and timing should be maintained.
Recommendation: Change operations to an inflow/outflow regulation schedule or add high/low limits to rainfall operational rules. Note that the 1995 Base, which employs a regulation schedule, is best so far at minimizing combined high and low water (9% of time vs. 20% for Alternatives 3 and 4 and 40% for 2050 Base).

ROTENBERGER WILDLIFE MANAGEMENT AREA:
Performance Measure: Inundation Duration (Indicator Region 28).
Planning Targets: Match NSM #, mean duration and % of time.
☺ **Evaluation**: Alternative 4 matches NSM hydroperiod (79%); this is much improved over the 1995 Base (59%, too short) and 2050 Base (86%, too long). Alternative 4 performance is similar to Alternative 3.

Performance Measure: Timing of Depth Variations (Indicator Region 28).
Planning Targets: Match NSM timing of peaks and pattern of variability.
☺ **Evaluation**: Alternative 4 timing and seasonal depth pattern matches NSM and are somewhat improved over 1995 Base; this is similar to Alternative 3 and 2050 Base.

Performance Measure: Extreme High Water (Indicator Region 28).
Planning Targets: (1) Minimize and (2) be less than or equal to NSM for each of three scores: # events; mean duration; and % of time > 1.5 ft depth.

☹ **Performance**: Alternative 4 exceeds 1.5 ft 16 times, averaging nine weeks duration and 9% of total time. This is identical to Alternative 3, much worse than 1995 Base (0% of time), but much better than 2050 Base (18% of time). Only one of six scores achieves its target (mean duration of high water is slightly shorter than NSM). Such frequent high water is likely to flood fire-damaged tree-islands and promote cattail proliferation.

Performance Measure: Extreme Low Water (Indicator Region 28)
Planning Target: (1) minimize and (2) be less than or equal to NSM for each of three scores: # events; mean duration; and % of time < -1.0 ft depth.
☹ **Performance**: Alternative 4 has 17 dryouts below –1.0 ft averaging seven weeks in length (8% of total time). This is identical to Alternative 3, much improved over the 1995 Base (19% of time), but worse than the 2050 Base (5% of time). Neither NSM nor soil protection targets are met.
Improvements needed: Overall, Alternative 4 (like Alternative 3) spends 17% of time in either high or low water conditions. There is therefore a need to reduce both high and low water events.
Recommendation: Same as for Holey Land Wildlife Management Area: change operations to an inflow-outflow regulation schedule or add high/low limits to rainfall plan.

LOXAHATCHEE NATIONAL WILDLIFE REFUGE:
Performance Measure: Inundation Duration (Indicator Regions 26&27).
Planning Targets: Match NSM #, mean duration and % of time.
😐 **Evaluation**: Alternative 4 hydroperiods exceed NSM in the south (Indicator Region 26), but are similar to NSM in the north (Indicator Region 27). Overall, Alternative 3 is more similar to NSM in its inundation pattern. Alternative 4 hydroperiod is 5% longer than the 2050 Base.

Performance Measure: Extreme High Water (Indicator Region 26 & 27).
Planning Targets: (1) minimize and (2) be less than or equal to NSM for each of three scores: # events; mean duration; and % of time > 2.5 ft depth
☹ **Performance**: In the north, Alternative 4 achieves its high water, with only one event of one week duration; its performance is similar to Alternative 3 and 2050 Base, and shows improvement over 1995 Base. In the south, Alternative 4 has 27 events greater than 2.5 ft averaging 15 weeks duration for 24% of total time; this greatly exceeds Alternative 3 and target values; performance here is similar to both bases.

Performance Measure: Extreme Low Water (Indicator Region 26 & 27).
Planning Target: (1) minimize and (2) be less than or equal to NSM for each of three scores: # events; mean duration; and % of time < -1.0 ft depth.
☺ **Evaluation**: Satisfactorily meets all criteria.
Improvements needed: If NSM patterns are desired there is a need to reduce depths in the southern part of Loxahatchee National Wildlife Refuge.

WCA-2A:
Performance Measure: Inundation Duration (Indicator Region 24 and 25).

Planning Targets: Match NSM #, mean duration and % of time.
😐☹ **Evaluation**: Hydroperiods in northern WCA-2A (Indicator Region 25) in Alternative 4 are longer than the 1995 and 2050 bases but they overshoot NSM by 6%. Although this is an improvement relative to the bases, Alternative 3 is a better match in the north. In southern WCA-2A, however, Alternative 4 is a better match for NSM, with a slight improvement over Alternative 3 and much improvement over the bases.

Performance Measure: Timing of Depth Variations (Indicator Region 24 & 25).
Planning Targets: Match NSM timing of peaks and pattern of variability.
😐**Evaluation**: Dry season depths in northern WCA-2A (Indicator Region 25) exceed NSM by about 0.25 ft, whereas Alternative 3 and the bases are similar to NSM depths. Like previous alternatives, wet season depths peak earlier than in NSM. Interannual standard deviations are smaller and more NSM-like, which is an improvement over the bases and similar to Alternative 3.

Performance Measure: Extreme High Water (Indicator Region 24 & 25).
Planning Targets: (1) Minimize and (2) be less than or equal to NSM for each of three scores: # events; mean duration; and % of time > 2.5 ft depth
☹**Performance**: There are 13 events averaging five weeks in South WCA-2A. Alternative 4 is not as successful as Alternative 3 or the bases in reducing high water events. Alternative 4 also performs worse than Alternative 3 or the bases during extreme high water events in southern WCA-2A.

Performance Measure: Extreme Low Water (Indicator Region 24 and 25).
Planning Target: (1) Minimize and (2) be less than or equal to NSM for each of three scores: # events; mean duration; and % of time < -1.0 ft depth.
☺ **Evaluation**: NSM low water targets are met throughout WCA-2A. Overall, Alternative 4 meets exceedence targets more successfully than Alternative 3 and the Bases.
Improvement needed: Reduce hydroperiods in the north and high water events in the south.

WCA-2B:
Performance Measure: Inundation Duration (Indicator Region 23).
Planning Targets: Match NSM #, mean duration and % of time.
☹**Performance**: Alternative 4's hydroperiod of 70% is much less than NSM target of 95%. It is also lower than the bases and Alternative 3.

Performance Measure: Timing of Depth Variations (Indicator Region 23).
Planning Targets: Match NSM timing of peaks and pattern of variability.
☹**Performance**: Depths in Alternative 4 average about 1 ft below NSM year round. The 1995 Base is the best match so far to NSM depth patterns. The effort to reduce depths in this area worked, but too well.

Performance Measure: Extreme High Water (Indicator Region 23).

Planning Targets: (1) Minimize and (2) be less than or equal to NSM for each of three scores: # events; mean duration; and % of time > 2.5 ft depth
☺😑 **Evaluation**: High water events are much reduced in Alternative 4 compared to prior alternatives and the bases. However, Alternative 4 has three events averaging 21 weeks duration for 4% of total time, which is much higher than NSM (two events averaging three weeks).

Performance Measure: Extreme Low Water (Indicator Region 23).
Planning Target: (1) Minimize and (2) be less than or equal to NSM for each of three scores: # events; mean duration; and % of time < -1.0 ft depth.
☹**Performance**: Alternative 4 has 27 low water events averaging six weeks duration for a total of 11% of time. This is much worse that Alternative 3 and both bases.
Improvements needed: The combined frequency of high and low water periods equals 15% in Alternative 4, which is much better than Alternative 3 and both bases but still far from NSM, which has only 1% of time in extreme depths. Although Alternative 4 is the best alternative so far, hydroperiods need to be substantially lengthened to avoid risk of soil oxidation and muck fires.

NORTHWEST WCA-3A (N of Alligator Alley; W of Miami Canal):
Performance Measure: Inundation Duration (Indicator Region 20 & 22).
Planning Targets: Match NSM #, mean duration and % of time.
😑**Evaluation**: Alternative 4 matches NSM values in Indicator Region 22, but hydroperiod is shorter (90% vs. NSM 94%) in Indicator Region 20, with more, shorter periods of inundation. Both areas show substantial improvement over 1995 and 2050 Bases.

Performance Measure: Extreme High Water (Indicator Region 20 & 22).
Planning Targets: (1) Minimize and (2) be less than or equal to NSM for each of three scores: # events; mean duration; and % of time > 2.5 ft depth
☺ **Evaluation**: Alternative 4 meets all targets in both indicator regions.

Performance Measure: Extreme Low Water (Indicator Region 20 & 22).
Planning Target: (1) Minimize and (2) be less than or equal to NSM for each of three scores: # events; mean duration; and % of time < -1.0 ft depth.
😑 **Evaluation:** Alternative 4 is better than 2050 Base, much better than 1995 Base, and slightly improved over Alternative 3. However, Alternative 4 still exceeds NSM, slightly, in the number and % time in dry-out events.
Improvements needed: Although it may not be possible to achieve the zero event target for protection of peat soils, it should at least be possible to reduce low water events below NSM values (fewer than 5-6 events totaling no more than 2% of time).
Recommendation: Increase dry season deliveries to NW WCA-3A.

NORTHEAST WCA-3A (N of Alligator Alley; E of Miami Canal):
Performance Measure: Inundation Duration (Indicator Region 21).
Planning Targets: Match NSM #, mean duration and % of time.

☹**Performance**: Alternative 4 hydroperiod is 5% shorter than NSM. This is a deviation in the opposite direction from the wetter 2050 Base (90%) and Alternative 3 (92%).

Performance Measure: Timing of Depth Variations (Indicator Region 21).
Planning Targets: Match NSM timing of peaks and pattern of variability.
☺ **Evaluation**: Alternative 4 timing and seasonal depth pattern is similar to NSM.

Performance Measure: Extreme High Water (Indicator Region 21).
Planning Targets: (1) Minimize and (2) be less than or equal to NSM for each of three scores: # events; mean duration; and % of time > 2.0 ft depth .
☹**Performance**: There are five high water events averaging six weeks duration for 2% of total time. High water events exceed NSM values. Alternative 4 has more events that are slightly shorter in duration than Alternative 3. Overall, Alternative 4 does not meet any targets for reduction in high water.

Performance Measure: Extreme Low Water (Indicator Region 21).
Planning Target: (1) Minimize and (2) be less than or equal to NSM for each of three scores: # events; mean duration; and % of time < -1.0 ft depth.
☹**Performance**: Alternative 4 is similar to NSM but still dries out below –1.0 ft on 17 occasions as compared to 11 occasions in Alternative 3. This is better than the 1995 Base but worse than the 2050 Base. Such a large number of drying events is likely to lead to further loss of peat soils in this area.
Improvements needed: Decrease the number and duration of low water events in Indicator Region 21 to protect already-impacted peat soils. Also, decrease number and duration of high water events, to protect tree islands and wading bird nesting habitat.
Recommendation: Overall, the stage duration curve in this area needs to be less steep with a longer duration of inundation combined with fewer low water and high water extremes. This problem occurs throughout eastern WCA-3A, WCA-3B, and extends into NE Shark Slough, so a regional solution is required.

EAST WCA-3A (S of Alligator Alley; E of Miami Canal):
Performance Measure: Inundation Duration (Indicator Region 19).
Planning Targets: Match NSM #, mean duration and % of time.
☺ **Evaluation**: Alternative 4 is similar to NSM and improved over Alternative 3 and both bases.

Performance Measure: Timing of Depth Variations (Indicator Region 19).
Planning Targets: Match NSM timing of peaks and pattern of variability.
☹**Performance**: Timing of high and low average depths in Alternative 4 is similar to NSM; however the interannual standard deviation in Alternative 4 is much larger than NSM and larger than Alternative 3 and both bases, reflecting a tendency toward more extreme depths differences between high and low rainfall years.

Performance Measure: Extreme High Water (Indicator Region 19).
Planning Targets: (1) Minimize and (2) be less than or equal to NSM for each of three scores: # events; mean duration; and % of time > 2.5 ft depth.

☹**Performance**: Alternative 4 has 21 events over 2.5 ft depth, averaging nine weeks duration for 12% of total time. Alternative 4 meets none of the targets, although it is slightly improved over Alternative 3. Alternative 4 is similar to 2050 Base and much improved over 1995 Base. The overall median depth exceeds NSM by about 0.6 ft.

Performance Measure: Extreme Low Water (Indicator Region 19).
Planning Target: (1) Minimize and (2) be less than or equal to NSM for each of three scores: # events; mean duration; and % of time < -1.0 ft depth.
☹**Performance**: Alternative 4 has ten low water events averaging four weeks duration for 3% of total time. This frequency is similar to NSM, but is higher than either Alternative 3 or the bases.
Improvements needed: The combined frequency of high and low water is lowest in 2050 Base (12%); Alternative 3 and Alternative 4 are similar (14% and 15%, respectively); all three exceed NSM (2%). Overall, there is a need to reduce extreme depths. This is part of the same problem that occurs throughout eastern WCA-3A, WCA-3B, and extends into NE Shark Slough, so a regional solution is required.

WCA-3A (S of Alligator Alley; W of Miami Canal):
Performance Measure: Inundation Duration (Indicator Region 14,17 and 18).
Planning Targets: Match NSM* in #, mean duration and % of time.
(*NSM targets for Indicator Region 17 were adjusted by using the average for Indicator Region 14 and Indicator Region 18.)
☺ **Evaluation**: Hydroperiods in Indicator Regions 14 and 17 match NSM targets, but may be slightly too long in Indicator Region 18 (97% vs. 92% for NSM).

Performance Measure: Timing of Depth Variations (Indicator Region 14,17 and 18).
Planning Targets: Match NSM timing of peaks and pattern of variability.
☺ **Evaluation**: All three regions show good matches with NSM targets.

Performance Measure: Extreme High Water (Indicator Region 14,17 and 18).
Planning Targets: (1) Minimize and (2) be less than or equal to NSM* for each of three scores: # events; mean duration; and % of time > 2.5 ft depth
(*NSM targets for Indicator Region 17 were adjusted by using the average for Indicator Region 14 and Indicator Region 18.)
☺ **Evaluation**: Alternative 4 is much improved over 1995 and 2050 Bases as well as Alternative 3 in Regions 14 and 17; Alternative 4 is equal to or slightly better than Alternative 3 and the bases in Region 18. There remain two high water events (1994 and 1995) with mean durations over 2.5 ft of 3-6 weeks. All three regions are close to NSM target values but still exceed them in event duration. Overall, seven of 15 target values are met, which may be the maximum that can be achieved.

Performance Measure: Extreme Low Water (Indicator Region 14,17 and 18).
Planning Target: (1) Minimize and (2) be less than or equal to NSM* for each of three scores: # events; mean duration; and % of time < -1.0 ft depth.
(*NSM targets for Indicator Region 17 were adjusted by using the average for Indicator Region 14 and Indicator Region 18.)

☺😐 **Evaluation**: The three regions have 2-4 low water events averaging 3-5 weeks. Alternative 4 has more low water events than Alternative 3 or the bases in Region 14, but fewer in Regions 17 and 18.
Improvement Needed: The combined percent of time for both high and low water events is much shorter in Alternative 4 (2-4% of time) than in Alternative 3 (4-5%), 2050 Base (4-6%), and 1995 Base (4-36%). Maintain current performance.

WCA-3B:
Performance Measure: Inundation Duration (Indicator Region 15).
Planning Targets: Match NSM #, mean duration and % of time.
☺ **Evaluation**: Hydroperiod in Alternative 4 matches NSM target of 94%; this is an improvement over Alternative 3, which was inundated for too long (99% of time).

Performance Measure: Timing of Depth Variations (Indicator Region 15).
Planning Targets: Match NSM timing of peaks and pattern of variability.
☹**Performance**: Alternative 4's interannual standard deviation is much larger than Alternative 3, NSM, or the bases. Dry season average minimum is similar to NSM but wet season average maximum is about 0.75 ft deeper than NSM (as well as slightly deeper than Alternative 3).

Performance Measure: Extreme High Water (Indicator Region 15).
Planning Targets: (1) Minimize and (2) be less than or equal to NSM for each of three scores: # events; mean duration; and % of time > 2.5 ft depth**.**
☹**Performance**: Alternative 4 has 18 high water events averaging eight weeks for a total of 9% of time. This is worse than Alternative 3 and both bases. It does not meet NSM targets (six events averaging six weeks; 2% of time). Such high water would have negative ecological impacts, especially for tree islands.

Performance Measure: Extreme Low Water (Indicator Region 14,17 and 18).
Planning Target: (1) Minimize and (2) be less than or equal to NSM for each of three scores: # events; mean duration; and % of time < -1.0 ft depth.
☹**Performance**: Alternative 4 has seven low water events averaging five weeks in duration for a total of 2% of time. This is worse than Alternative 3 and both bases and does not meet NSM targets.
Improvements needed: The combined percent of time for both high and low water events is much larger in Alternative 4 (11% of time) than in Alternative 3 (4%), 2050 Base (4%), 1995 Base (1%), and NSM (2%). There is a need to reduce extreme depths substantially. This is part of the same problem that occurs throughout eastern WCA-3A and extends into NE Shark Slough, so a regional solution is required.

PENNSUCO WETLANDS:
Performance Measure: Inundation Duration (Cell R26C27).
Planning Targets: Match NSM #, mean duration and % of time.
Evaluation: Alternative 4's hydroperiod of 84% is similar to NSM (87%) and improved over Alternative 3 (93%) and both bases (81%).

Performance Measure: Timing of Depth Variations (R26C27) Planning.
Targets: Match NSM timing and pattern of variability.
Evaluation: The stage duration curve for Alternative 4 is overall more similar to NSM with respect to median, low and high depths, than is Alternative 3 or the 1995 or 2050 bases. However, median depths and wet season high water exceeds NSM by 0.2 to 0.4 ft, approximately, while dry-outs are more severe than NSM by about 0.4 ft.
Improvements needed: Reduce extremes of high and low water.

F. SOUTHERN EVERGLADES

Performance Measures: Ecological: Native and introduced aquatic organisms in canals.
Hydrological: Ponding depth differences SFWMM v 3.4 relative to NSM v 4.5, 1989 hydroperiod differences alternative 3 SFWMM v 3.4 relative to NSM v 4.5.
Goal: Match NSM characteristics of the system.
Performance: Canals and levees promote the extremes of ponding and overdrainage, with concomitant negative effects on freshwater aquatic communities. They increase the potential for dispersal of introduced plants and animals, and alter energy flow patterns in adjacent wetlands.
Improvement Needed: Restoration of sheetflow to the historical central flow way of the southern Everglades and to short-hydroperiod marshes to the east and west of this central flow way. Eliminate canals as an artificial habitat and conduits for water routing and dispersal of plants and animal. Degrade levees that act as barriers to water flow and movement of aquatic animals and as conduits for exotic terrestrial biota.
Recommendation: Decompartmentalization of the entire Everglades Protection Area.
Structural/Operational Changes: Restore sheetflow throughout the Everglades Protection Area. Fill canals, degrade levees, place roads on causeways traversing interior marshes to allow unimpeded flow. Use the lowest management intensive strategies to establish rainfall-based flows.

Performance Measures: Ecological: Tree island hammocks, peat forming communities, average water depth during peak alligator mating period in Shark Slough, freshwater fishes and invertebrates, amphibians and reptiles, marl prairie
Hydrological: Inundation duration summaries (Indicator Regions 10, 11), normalized weekly stage duration curves mid-Shark River Slough (Indicator Region 10), and for NE Shark River Slough (Indicator Region 11), temporal variation in mean weekly stage for rockland marl marsh (Indicator Region 8), normalized weekly stage duration curves for rockland marl marsh (Indicator Region 8).
Goal: Match NSM
Performance: Flood releases; reduced hydroperiods; low minimum stages; high frequency of dry downs.
Improvement Needed: Rainfall-based flows must extend from the upper to the lower reaches of the Everglades catchment area. Flows must be provided in sufficient volume to maintain dry season pool formations that persist within the downstream reaches of the system. Uninterrupted sheet flow through the entire system is needed and should be driven by adequate water storage in areas north of the Everglades Protection Area. Eliminate flood releases. Restore NSM hydropatterns.

Recommendation: Provide adequate water storage in areas north of the Everglades Protection Area to restore NSM hydropatterns. Explore using the lowest management intensive strategy to establish rainfall-based flows.
Structural/Operational Changes: Maintain stages adjacent to the Everglades Protection Area at levels that will prevent drainage or natural areas.

G. ESTUARIES

CALOOSAHATCHEE ESTUARY:

Performance Criteria: The Number of times salinity envelope criteria were not met for the Caloosahatchee Estuary.
Target: To meet minimum flow at Caloosahatchee (300cfs).
Performance: The number of minimum flow violations is only one month away from the target (60).

Performance Criteria: Number of times high discharge criteria (mean monthly flow > 2,800 and 4,500 cfs) were exceeded for the Caloosahatchee Estuary.
Target: No regulatory releases from Lake Okeechobee are desired.
Performance: Alternative 4 was identical to Alternative 3 except that the one regulatory release was removed.
Recommendations: Overall, in Alternative 4 the Caloosahatchee is almost at its target values (good job!!!!!).

ST. LUCIE ESTUARY:

Performance Criteria: Number of times salinity envelope criteria were not met for the St. Lucie Estuary.
Target: To meet minimum flow to St. Lucie Estuary (350cfs).
Performance Criteria: Number of times high discharge criteria (mean monthly flow > 1600 & 2500 cfs) were exceeded for St. Lucie Estuary.
Target: No regulatory releases from Lake Okeechobee are desired.
Note: Overall, the additional basin storage in Alternative 4 was a large improvement over Alternative 3. The high flow (>1,600cfs) was decreased and the low flow target (<350cfs) has been attained. The one regulatory release was removed.
Recommendations: Continue moving toward meeting the target for high (>1,600cfs) flows. Increased storage would be one method of meeting the target. Additionally, the storage in the basins is one large reservoir. Adding additional reservoirs to each basin would possibly help attain the target.

LAKE WORTH LAGOON:

Performance Criteria: Wet/Dry Season Average Flows Discharged to Lake Worth through S40, S41 & S155 for the 31-year Simulation.
Target: To meet target flows to the Lake Worth Lagoon (0 - 500 cfs).
Performance: Alternative 4 displayed an improvement over Alternative 3, but is still a long way from the target.
Recommendation: Continue moving toward increasing the number of low flow months and decreasing the number of high flow (>500cfs) months.

BISCAYNE BAY:
Performance Criteria: Simulated mean annual surface flows discharged into Biscayne Bay for the 1965-1995 simulation period.
Target: 1995 Base condition.
Performance: Decreased flow to Biscayne Bay. In most of the areas Alternative 4 does not improve over Alternative 3. North Bay did improve almost to the 1995 Base.
Recommendations: Improve estuarine conditions by increasing water flow to Biscayne Bay. At the minimum, try and reestablish the 1995 Base flow to Biscayne Bay.
Note: Innovative methods such as wastewater reuse need to be explored.
Recommendations: 1. Incorporate the new performance criteria for Snake Creek. This criteria establishes a maximum salinity of 20ppt. 2. Distribution of surface flows over a wider section of shoreline, as opposed to point discharge through canals. 3. A wet and dry season allocation for Barnes Sound preferably as sheet flow through the mangrove system in the triangle is needed. 4. A higher wet season and dry season water table on the coastal ridge is needed to stimulate groundwater flow. 5. Dry season allocations through all Biscayne Bay canals are needed.

FLORIDA BAY:
Performance Measure: Salinity/P33 stage regressions.
Target: P33 stages above 6.3 ft and 7.3 ft MSL.
Performance: In comparison to Alternative 3, Alternative 4 had a negative influence on salinity in the coastal basins of Florida Bay, as simulated by salinity/P33 stage regressions. The frequency of undesirable high-salinity events increased slightly, and the frequency of desirable low-salinity events decreased slightly.
Performance: P33 stages above 6.3 ft msl correspond to a reduced frequency of undesirable high salinity events in the coastal basins of Florida Bay. There are approximately 53 months of the period of record when NSM 4.5 exceeds that stage, but Alternative 4 does not, which is less desirable than the 48 months in Alternative 3. These events occurred in the November-May dry season during 33 months over 22 years, and in the June-October wet season during 20 months over 13 years of the 31-year period of record.
Performance: P33 stages above 7.3 ft msl correspond to an increased frequency of desirable low salinity events in the coastal basins of Florida Bay. There are approximately 18 months of the period of record when NSM 4.5 exceeds that stage, but Alternative 4 does not, which is less desirable than the 16 months in Alternative 3. These events occurred in the November-May dry season during five months over four years, and in the June-October wet season during 13 months over eight years of the 31-year period of record.
Performance: Alternative 4 resulted in deficiencies in 6.3+ and 7.3+ ft stages at P33 most frequently during the dry season months of January and February and the wet season months of June-August.
Recommendation: Future alternatives should concentrate on maintaining higher stages at P33 via larger water deliveries into NE Shark River Slough in the mid-to-late dry season, particularly during January and February, and in the early-to middle wet season during June-August.

INDICATOR REGION 8, ROCKLAND MARL MARSH:
Performance measures: Duration of Flooding.
Target: NSM.
Performance: The mean duration of flooding in the rockland marl marsh indicator region remains two months shorter under Alternative 4 than under NSM.

Performance Measure: Maximum Water Depth Below Ground During Drought.
Target: NSM.
Note: The performance measure of maximum water depth below ground during drought has been achieved in both Alternatives 3 and 4. The maximum water depth below the ground surface during dry conditions averaged 2.0 ft (max = 3.6 ft) under Alternative 4, 2.2 ft (max = 3.8 ft) under Alternative 3, and 2.0 ft (max = 3.9 ft) under NSM (Table 6). Both Alternatives 3 and 4 are very close to NSM regarding maximum water depth below ground during drought

Performance Measure: Water Depth > 6 Inches During Periods of Flooding.
Target: NSM.
Note: The performance measure of water depth > 6 inches during periods of flooding has been achieved in both Alternatives 3 and 4. Alternatives 3 and 4 indicate average water depths of 0.6 and 0.7 ft during periods of flooding compared to 0.7 ft under NSM.
Recommendation: Future alternatives should increase periods of flooding by an average of two months by extending hydroperiods further into the dry season, particularly during January and February, and by restoring the multi-year period of flooding during 1979-80 that occurs under NSM but is broken by dry conditions under Alternative 4.

INDICATOR REGION 11, NE SHARK RIVER SLOUGH:
Performance Measure: Frequency of dry-outs
Target: NSM.
Performance: NE Shark River Slough dries out 11 times in Alternative 4 and nine times in Alternative 3 compared to only one time under NSM during the period of record. The excessive number of drydown events in Alternatives 3 & 4 commenced most often during April. The mean depth during flooding is also reduced by approximately 0.5 ft under Alternatives 3 & 4 compared to NSM.
Recommendation: Reduce the number of dry events in Northeast Shark River Slough Indicator Region from the nine to 11drydowns under Alternatives 3 & 4 to no more than one drydown as indicated by NSM for the period of record. Accomplish this by extending hydroperiod into the dry season through April, even during most of the low-rainfall years.

INDICATOR REGION 3, MID PERRINE MARL MARSH:
Performance Measure: Duration of flooding.
Target: NSM.
Performance: The mean duration of flooding in the mid-Perrine marl marsh indicator region remains one month shorter under Alternatives 3 & 4 than under NSM.

Recommendation: Future alternatives should increase periods of flooding by an average of one month by extending hydroperiods further into the dry season, particularly during January or February.

H. BIG CYPRESS SUBREGION

Performance Measure: Annual Average Hydroperiod Difference maps.
Target: Restore NSM conditions.
Performance: The Annual Average Hydroperiod Difference maps have consistently shown drier than NSM conditions in a large area in the northeast corner of the Big Cypress. The most significant problem area is bounded by the L-28 Interceptor and the north end of L-28 (Indicator Region 43, Normalized Weekly Stage Duration Curve and Temporal Variation in Mean Weekly Stage). It has 90 to 365 days shorter hydroperiods and a water table that is consistently 1-2.5 ft below NSM year-around levels. A significant but smaller problem area, with 90 to 180 days shorter hydroperiods, occurs at the west end of the Western Feeder Canal. However, this area lies along the model boundary, where models tend to be less accurate. The problem continues with less severity (30-90 days shorter hydroperiods and 0.2-0.5 ft below NSM year-around water levels) to the west of the L-28 Interceptor, and south and west of the Western Feeder Canal that flows into the L-28 Interceptor. The subteam is interested in trying to understand where these problems were real, as opposed to possibly being associated with problems with the model, such as boundary influences or inadequate information upon which to base an accurate model of the area.
Note: None of the bases or alternatives have significantly influenced hydrologic conditions in the northeast corner of the Big Cypress
Recommendations: As a result of the above observations, a number of recommendations were agreed upon by the L-28 Interceptor Design Team to evaluate the effects of the existing structures on the hydrology of this region:
1. Degrade the western levee of the L-28 Interceptor and fill the canal to restore overland flows to adjacent wetlands and to reduce the point source of flows and nutrients at the end of the canal. The levee on the east side of the canal would remain to protect the developed lands to the east.
2. The S-190 culvert structure would have to be replaced with a pump station to maintain the current level of drainage of the upstream developed area, when the downstream canal was filled.
3. Allow water in the Western Feeder Canal to flow south. Various suggestions from the Seminole representative and National Park Service staff suggested the possibility of breaching the levee along the south side of the canal or siphons that could carry water over the levee.
4. Since nutrient loads in these waters appear to be increasing over time as the upstream watershed is developed, there should be an evaluation of the need for a Water Preserve Area or Stormwater Treatment Area.
5. There was concern about improving drainage of the land between the north L-28 and L-28 Interceptor. All water currently leaving the north L-28 is pumped out by the S-140 structure, since this canal dead-ends at the L-28 Interceptor Levee. A more efficient system would be to install a weir on L-28 south of S-140 and a new pump station further

south on L-28. In Alternative 4, water is entering WCA-3A from an 8-mile-long spreader canal at the bottom end of L-28 north canal. If this latter design is maintained, this recommendation would adequately addressed.

Performance Measure: Annual Average Hydroperiod Differences, Frequency of Peak Stage Differences.
Target:
Performance: In the area south and southwest of the junction of Tamiami Trail and L-28, there are mixed signals as to whether the area is getting wetter or drier depending on the performance measure used. Annual Average Hydroperiod Differences from NSM suggest that there was no change between Alternatives 3 and 4, while Hydroperiod Benefits / Impacts suggest that the area is getting wetter. Frequency of Peak Stage Differences suggests that the area showing a slightly higher frequency of lower water levels is decreasing from Alternatives 3 to 4. Therefore, this area is getting wetter. The West Slough Indicator Region 13 suggests that this area has steadily gotten drier from Alternative 2 through Alternative 4. The Lostman's flow cross-section also has shown a steady progression among the alternatives from higher to lower than NSM conditions in Alternative 4. Thus, the Regional Map Performance Measures suggest wetter conditions and the indicator region and flow cross-section suggest drier conditions in the same general area.
Recommendation: Evaluate whether these discrepancies between the performance measures are real or are more likely just a function of inherent uncertainty within the model.

I. WATER QUALITY

Performance Measure: Water Budgets.
Restoration Goal: From a water quality perspective, retaining natural system water in the natural system is preferred over discharging treated water back to the natural system (e.g., pH, conductivity, dissolved oxygen, etc.).
Performance: The conceptual plan developed for the Restudy by the Governor's Commission listed wastewater reuse as one of the 40 preferred options. To date, no additional wastewater reuse has been included in the alternative plans. Conserving and reusing water in urban/agricultural areas clearly benefits the natural system.
Recommendations: 1) The proposed West Dade reuse facility should be modeled in Alternative 5, as well as added to Alternatives 3 and 4. 2) The Restudy Wastewater Reuse Team is screening the applicability of wastewater reuse at other existing facilities in Palm Beach, Broward, and Dade counties. The Restudy Team should be prepared to incorporate additional wastewater reuse components identified during the initial screening.

Performance Measure/Indicator: Lake Okeechobee Water Budget.
Restoration Goal: Reduction of phosphorus loads to Lake Okeechobee.
Performance: Alternative 4 includes northern L-8 basin discharges to Lake Okeechobee totaling approximately 80 k acre-feet via the C-10A culvert and the yet-to-be constructed S-309 pump station. The L-8 Project which is part of the Everglades Construction

Project does not include treatment for these flows discharged to the lake; however, the conceptual design for the ECP indicates that agricultural runoff contained in L-8 flows contains total phosphorus with an average concentration of approximately 226 ppb.
Recommendation: Construct an STA in the L-8 basin to treat agricultural runoff.

Performance Measure/Indicator: Aquifer Storage & Recovery (ASR) Water Budgets.
Note: Alternative 4 includes 1,775 MGD of ASR (approximately 2.0 million acre-feet), including 1,000 MGD of ASR around Lake Okeechobee. ASR on this scale has not yet been implemented anywhere in the United States. In addition, there are, at present, significant regulatory issues which must be addressed by agency heads and technical staff prior to proceeding with assurance that ASR can be implemented on the scale suggested for the Restudy.

Performance Measure/Indicator: Annual Water Budget for WCA-1.
Restoration Goal: Ecologically preferred hydropatterns in Loxahatchee National Wildlife Refuge; additional water supplies to Everglades Agricultural Area/Lower East Coast/WCAs.
Performance: Alternative 4 includes approximately 39,000 acre-feet average annual volume discharged from the ACME basins to Loxahatchee National Wildlife Refuge. Improvement of ACME basin's water prior to discharge to Loxahatchee National Wildlife Refuge is a requirement of the non-ECP structures part of the Everglades Forever Act (without project condition); however, Loxahatchee National Wildlife Refuge staff are investigating whether the volume of water received via ACME is desirable (stage duration curve for gage 1-7, cell R48 C31 indicates that NSM is exceeded more than 60 percent of the time).
Recommendation: ACME water can be re-routed to the EAA for agricultural irrigation, Palm Beach County for water supply purposes, or WCA-2 to achieve NSM-like hydropatterns. ACME water can be stored in ASR wells to achieve hydrologic (timing) objectives. Alternative uses for ACME water, if preferred, could result in reduced treatment requirements.

Performance Measures: Lake Okeechobee Water Quality Model (mean phosphorus in-loads and out-loads, wet year and dry year phosphorus in-loads and out-loads, median phosphorus concentrations, median chlorophyll a concentrations, median blue-green algae concentrations, difference from 2050 base phosphorus concentration, difference from 2050 Base chlorophyll a concentrations, difference from 2050 Base blue-green algae concentrations.
Restoration Goal: Adequate water quality within Lake Okeechobee to sustain ecological functions.
Note: Alternative 4 was approximately equivalent to Alternatives 2 and 3 and 2050 Base conditions except that the proposed operating schedule for ASR withdrawals and recovery improved wet-year phosphorus out-loads compared to 2050 Base and Alternative 3.
Recommendation: See above. The Water Quality Team is investigating the affect of reducing phosphorous loads/concentrations (achieving some incremental level of lake restoration over the simulation period for the model on model results). Additionally, the

affect of running the model out to 2050 Base is also being evaluated (currently the simulation period for the model is 23 years).

Performance Measures: Everglades Water Quality Model (mean phosphorus loads to the Everglades Protection Area, combined flow-weighted phosphorus concentrations for S-12s/S33, mean grid cell phosphorus concentrations and differences, Loxahatchee National Wildlife Refuge 14-station mean phosphorus concentration, basin phosphorus concentrations) Alternative 4 model results not yet available.

J. ATLSS / THREATENED AND ENDANGERED / KEYSTONE SPECIES

An individual-based ATLSS simulation and Population Viability Analysis are now available for the western sub-population of the Cape Sable seaside sparrow. Breeding Potential Indices (BPIs) are addressed for other Cape Sable seaside sparrow sub-populations and white-tailed deer. For wading birds, ATLSS outputs for Alternative 4 include a Foraging Conditions Index with separate analyses for "short-legged" and "long-legged" species. Outputs on total fish abundance and fish prey base for wading birds are also available. Differences in input data make quantitative comparisons of Alternative 2, Alternative 3 and Alternative 4 outputs to Alternative 1 outputs and/or 1995 Base outputs impossible and makes qualitative comparisons questionable. Performance indicators for Cape Sable seaside sparrows and American crocodiles are also addressed.

FISH:
Performance Indicator: ATLSS fish model.
Goal: None set yet.
Performance: The ATLSS fish model predicts that, due to overall wetter conditions in WCA-3B, WCA-2A, west-central WCA-3A and south of Tamiami Trail, Alternative 4 hydrologic conditions will produce average fish abundances consistently higher than those expected for 2050 Base, particularly in Shark River Slough and WCA-3B. This is also true when only prey-sized fish at appropriate wading bird foraging depths are counted. Exceptions occur in WCA-2B, eastern WCA-3A, East Slough and South Big Cypress, where Alternative 4 produces slightly lower fish densities than the 2050 Base. Alternative 4 results are very similar to Alternative 2 and Alternative 3.

WADING BIRDS:
Performance Indicator: ATLSS wading bird Foraging Conditions Index.
Performance: 1. Eastern rookeries (WCA-3A, WCA-3B and NE Shark River Slough) - On average, Alternative 4 predicts slightly lower foraging condition values than 2050 Base for short-legged wading birds and equal to slightly higher values for long-legged wading birds in WCA-3A and NE Shark River Slough. Alternative 4 foraging values are consistently lower in WCA-3B for all wading birds due to deeper water.
2. Historic Shark Slough/mangrove estuary interface rookeries - Alternative 4 predicts consistently higher foraging condition values than 2050 Base for all wading birds.
3. Southern Big Cypress marshes - Alternative 4 foraging values are consistently lower than 2050 Base for all wading birds. Alternative 3 produced slightly better conditions in

the eastern rookeries and slightly worse conditions in the Shark Slough/mangrove rookeries as compared to Alternative 4.
Recommendation: Bring down overly deep water levels in WCA-3A and WCA-3B.

WHITE-TAILED DEER:
Performance Indicator: ATLSS white-tailed deer Breeding Potential Index.
Performance: Alternative 4 would slightly improve the generally poor breeding conditions for white-tailed deer in SE Big Cypress, NW ENP, Holey Land, Rotenberger, southern WCA-3A and WCA-2B as compared to the 2050 Base, particularly in years with average to above average rainfall. Alternative 4 would slightly decrease the very low breeding potential in central Shark Slough and other portions of the WCAs as compared to 2050 Base. For those few areas with high deer breeding potential (Long Pine Key and surrounding short hydroperiod marsh and NW Big Cypress), there is little difference between Alternative 4 and the 2050 Base. Overall, Alternative 4 produces slightly better deer breeding potential in Holey Land, Rotenberger and WCA-2B than Alternative 3 or Alternative 2.
Recommendation: No recommendations are provided for desired improvements or structural/operational changes because no performance target has been set.

CAPE SABLE SEASIDE SPARROW:
Performance Indicator: Indicator Region 46 - Cape Sable seaside sparrow west.
Performance: On average, during the sparrow breeding season, Alternative 4 is dryer than the 2050 Base, NSM, Alternative 2 and Alternative 3. The 1995 Base and Alternative 4 produce dry conditions at about the same time and the 1995 Base re-floods the area about one week earlier than Alternative 4.

Performance Indicator: ATLSS Cape Sable seaside sparrow Breeding Potential Index.
Performance: For the western sparrow sub-population, Alternative 4 produced slightly improved breeding potential in the northern portions of this habitat, and slightly lower breeding potential in the southern portions as compared to the 2050 Base, with a slight net improvement for this sub-population over 2050 Base and Alternative 2. An important difference between Alternative 4 and Alternative 3 in the western subpopulation area is Alternative 4's improved breeding potential in some high water years. For the core and eastern sub-populations, Alternative 4 consistently produces lower breeding potential than the 2050 Base and slightly lower breeding potential than Alternatives 2 and 3.
Recommendations: For the core habitat area east of Shark Slough, reduce dry season depths in order to preserve breeding potential in the sparrow's most stable subpopulation. For the eastern habitat areas, slightly reduce dry season depths to improve breeding potential while preserving expected beneficial effects to sparrow habitat due to reversal of shrub invasion.

Performance Indicator: ATLSS Cape Sable seaside sparrow Individual-based Simulation.
Performance: The ATLSS individual-based sparrow simulation is applied only to the western sub-population, and predicts persistence of this sub-population under Alternatives 3 and 4. A Population Viability Analysis using the individual model

predicts that the western subpopulation will be slightly more likely to remain above minimum numbers and reach or exceed maximum numbers under Alternative 4. Under the 2050 Base, this model consistently predicts extirpation of the western sub-population. **Recommendations:** Decreased dry season water levels during wet years in the southeastern portion of the western sub-population area (roughly Indicator Region 7) could improve sparrow individual simulation results.

AMERICAN CROCODILE:
Performance Measure: Proposed measure is being programmed.
Performance: In absence of performance measure outputs, inspection of available Florida Bay salinity outputs indicates reduced salinities under Alternative 4 that would correspond to increased crocodile habitat suitability as compared to the 2050 Base, 1995 Base, Starting Point and Alternatives 1-2. However, Alternative 4 produces slightly higher mean salinities in many months, and slightly poorer performance for the number of times salinity criteria are exceeded than does Alternative 3.
Recommendations: Increased flows to Florida Bay, particularly in dry years.

AET Subteam Narratives

A. Total System Subregion

Performance Based Comments:

The natural environment has been compartmentalized and flow patterns severely altered by the C&SF Project. Generally, in comparison to Alternative 3, Alternative 4 improves flow patterns through the WCA-3A (south), B and the Park. Although Alternative 4 is moving in the right direction to more closely resemble NSM conditions, velocities along the eastern boundary and through Shark River Slough are much greater than are indicated under natural conditions.

NSM for the dry year 1989 indicates the persistence of several long-hydroperiod areas connected by intermediate hydroperiod class wetlands. Alternative 4 shows a more chopped up pattern: a large pool persists in west-central WCA-3A during 1989, as well as a large pool (hydroperiods are 240-300 days, 300-330 days, and 330-365 days) in the southern portion of Loxahatchee. Northern portions of WCA-2A also stay wet longer than conditions indicated by the NSM. In contrast, WCA–2B is dryer. The Park is also too dry during ’89 in Alternative 4: Shark River Slough dries out (hydroperiod classes are mostly 240-300 days with some 300-330 days), and many areas in the Park have hydroperiods shorter than NSM. However, during a wet year (1995) Alternative 4 more closely matches NSM with the following exceptions: areas (grids) in southern WCA-2B are drier than NSM and a few grids within the central southern portion of the Park and Model Lands are also wetter in Alternative 4 than NSM during 1995.

Hydroperiod Differences Relative to NSM: For Alternative 4, the dry year (1989) modeled was dryer for the following areas: most of WCA-2B was 90-180 and 180-365 days drier; much of WCA-3B was also dry during ’89. Shark River Slough hydroperiods

were on average 30-60 days shorter. NESRS had hydroperiods 60-90 days and 90-180 days shorter. Some areas in Model lands show longer hydroperiods. Also, a few grids in eastern ENP show hydroperiods 30-60 and 60-120 days longer.

Hydroperiod Differences Relative to 2050: Limited improvements (hydroperiods are moving in the direction of NSM) to remaining natural areas (535,040 acres); however, 215K acres were too dry, 281K acres didn't change, and 376K acres overshot NSM conditions.

Alternative 4 ponding depths oscillate between extreme highs during wet periods to extreme lows during dry periods. This results in ponding averages looking pretty good when in fact they are not. Need more moderation in ponding depths. WCA-2B and WCA-3B are particularly effected by extreme high and low ponding depths. However, areas north of the Trail improved when comparing Alternative 4 with Alternative 3. Also, Alternative 4 conditions improved over 2050 Base conditions (2050 results show ponding depth differences of 0.5 to 1.0 ft below NSM).

Performance Measures and Indicators Used:
1. Mean Annual Overland Flow
2. Hydroperiod Distribution Maps and Charts
3. Hydroperiod Improvement
4. Ponding Depth and Depth Differences map and histograms.

Recommendations:
1. Additional improvements in overland flow are needed, particularly in patterns through WCA-2A, B and Loxahatchee, and velocities through Shark River Slough.

2. Continue improvements made in dry year pools and patterns. Continue improvements to long hydroperiod areas, including the long hydroperiod sloughs (particularly Shark River Slough) in the Park.

3. The sloughs could still use longer hydroperiods.

4. Moderate ponding depths, particularly in WCA-2B.

Summary of Comments from Web Site:

NAME: Tom Corcoran
AFFILIATION: national audubon society
PERFORMANCE MEASURE: REGIONAL: Hydroperiod Distribution
EVALUATION:

Hydroperiod Differences Maps
1. The remaining differences between the NSM and any of the alternatives are most visible under drought conditions. For this reason a comparison between the Hydroperiod

Difference maps for 1989, alternative 3 and alternative 4 is of particular interest. For alternative 4 the ponding along Tamiami Trail in the area of S-12A and S-12B has disappeared along with the excessive dry-out just south of the Trail. Also, the dry-out in the northern part of the Miami canal, just below the EAA and the ponding in the northern part of L-67-A and L-67-C are much less pronounced.
2. For the 1965-1995 simulation period Hydroperiod Difference Maps alternative 4 creates some welcome further improvement over alternative 3 in the northern part of the Shark River Slough as well as in the northern reaches of Taylor Slough.

Overland Flow Pattern Maps
1. Referring to Overland Flow Pattern Maps, Alternative 4 appears to concentrate the flow into a smaller area in the width of Shark River Slough. The question is whether or not this is a desirable effect of decompartmentalization? An alternative may to be to utilize the canal and the structures along Tamiami Trail L-29 to create a more distributed flow pattern into Shark River Slough?
2. Referring to Overland Flow Pattern Maps, 1995 Alternative 4 appears to improve sheetflow north and south of Tamiami Trail significantly. This may indicate an improvement of particular significance. Wood Stork nesting success in the shark river rookeries collapsed immediately after the levee along L-29 was completed. 3 The surface water flow looks much better NSM like in alternative 4 versus alternative 3 in an average year, say 1991.

General Comments
1. Related to component WW4, would this new component enable the SFWMD to more effectively provide flood protection for the Homestead Agricultural Area without forcing the flood waters into Taylor Slough?

NAME: Tom MacVicar
AFFILIATION: Ag. Coalition
PERFORMANCE MEASURE: Stage Duration Curves at EAA Reservoir
EVALUATION: This refers to the 40,000 acre reservoir for Glades supply: The very limited use of this feature does not justify the cost. It also intercepts a significant amount of the flow that would otherwise go to the Everglades if the land were allowed to remain in agriculture. This component should be dropped.

B. Kissimmee / Lake Okeechobee Subregion

Performance-Based Comments:

There were no performance measures evaluated for the Kissimmee region.

Water inputs to the lake were increased by 39,000 acre ft (1%) under Alternative 4 as compared to the previous alternative. Water losses from the lake also increased by 39,000 acre ft (1%). Notable aspects of the water budget for Alternative 4 include: (a) 230,260 acre ft y^{-1} of water flow from the lake to ASR (aquifer storage and recovery) wells; (b) 116,210 acre ft y^{-1} of water return to the lake from those ASR wells; (c)

101,400 acre ft y^{-1} of water flow from the lake to north storage reservoirs; and (d) 50,340 acre ft y^{-1} of water flow to the lake from those storage reservoirs. As in previous alternatives, most (90%) of the water flowing towards the lake from Taylor Creek now is captured by a storage reservoir, from which it is periodically discharged to the lake. Alternative 4 also has considerably more water flow (446,000 acre ft y^{-1}) from the lake to the Everglades Protection Area (EPA) than previous alternatives and base runs.

These statistics raise some concerns. First, consideration needs to be given to the feasibility of ASR wells at the magnitude proposed in this plan. The AET Water Quality Subteam addresses this issue in greater detail. Second, consideration needs to be given to effects of storage reservoirs on discharge water quality. Reservoirs that are dry for long periods of time, and experience periodic spates of water with a short residence time, may actually be sources of nutrients. Finally, consideration needs to be given to the treatment (for nutrient removal) of large quantities of water flowing from the lake to the EPA in this alternative.

The stage duration curve for Alternative 4 has a similar "shape" to that displayed by Alternative 3, however, it is markedly depressed, especially at higher lake levels.

Box-and-whisker plots showing the "similarity in lake stages" indicate that 25th and 75th percentiles for water levels under Alternative 4 were within a 12 to 15 ft NGVD depth range, but the overall distribution of depths is depressed relative to Alternative 3. Extreme lows and highs still occur in Alternative 4, but at a relatively low frequency.

The daily stage hydrographs indicate the following return frequencies (number of events in 31 years) for extreme high (>17 ft NGVD) and low (<11 ft NGVD) lake stages:

Category	Goal	95 Base	50 Base	Alt 2	Alt 3	Alt 4
> 17 ft	few events	6	5	4	3	2
< 11 ft	few events	8	12	9	6	8

The changes under Alternative 4 represent positive results from the standpoint of protecting the lake ecosystem from extreme high water events. When lake levels reach 17 ft NGVD, wind-driven waves can seriously damage native plant communities and fisheries habitat, even in very short time periods, and there also may be considerable nutrient transport into the oligotrophic marsh from the eutrophic pelagic zone.

In contrast, the results of Alternative 4 reflect a deterioration of conditions in regard to extreme low water events. When lake levels fall below 11 ft NGVD, nearly all of the littoral marsh is exposed to drying, it no longer can serve as a habitat for fish and other aquatic animals, and it is at increased risk for expansion of exotic plants.

Box-and-whisker plots showing the similarity in duration of stage events >15 ft NGVD indicate that under Alternative 4, both the median and 75th percentile durations for such events were reduced to far below six months. This is a positive result. Prolonged periods of moderately high lake levels (which are rare under this alternative) harm the ecosystem due to losses of benthic plant communities, and greater lake-wide circulation of turbid, phosphorus-rich water. Increases in lake-wide phosphorus concentrations could impact downstream ecosystems that receive water from the lake.

Box-and-whisker plots showing the similarity in duration of stage events <12 ft NGVD indicate that under Alternative 4, both the median and 75th percentile durations for such events were markedly increased relative to Alternative 3. This is a negative result. Prolonged periods of moderately low lake levels harm the ecosystem due to losses of wildlife habitat and increased rates of exotic plant expansion.

Box-and-whisker plots showing the similarity in duration of stage events <11 ft NGVD indicate that under Alternative 4 there continued to be a relatively long median duration for such events, and an extreme value of >400 days. Such events are harmful to the ecosystem.

None of the scenarios evaluated to date, including Alternative 4, had significant effects on the frequency of occurrence for spring lake level recessions. In all cases, January to May recessions from 15 to 12 ft NGVD (without major reversals) occurred in approximately 20% of years. In light of the other positive results, and continued uncertainties regarding linkages between recession characteristics and ecological values, there are no strong recommendations to address the issue at this time.

Comments Received By Email from Outside Reviewers:

1. Thomas Corcoran (National Audubon Society)

> "Alt4 (10% of time exceeded) shows improvement compared to Alt3 (24% of time exceeded) on the stage duration curves in respect to lake stage exceeding 15 ft NGVD (the lake elevation above which the entire littoral zone is flooded)."
>
> "Alt 4 (22% of time exceeded) is worse compared to Alt3 (17% of time exceeded) on the stage duration curves in respect to the lake stages falling below 12 ft NGVD (below 12 ft more than 90% of the littoral zone is dry)."
>
> "Looking at the number of undesirable stage events it appears that Alt4 decreased the number of times stages are greater than 17 ft for greater than 50 days by about 33% compared to Alt3. The number of times stage is less than 12 ft for greater than one year has doubled. The number of times stage is less than 11 ft for greater than 100 days has remained the same.

The number of times stage events are greater than 15 ft for greater than 2 years is still eliminated."

Performance Measures and Indicators Used:

Measures: box-whisker plots showing similarity in lake stages
box-whisker plots showing duration of >15 ft lake stage events
box-whisker plots showing duration of <12 ft lake stage events
box-whisker plots showing duration of <11 ft lake stage events
daily hydrographs with spring recession windows

Indicators: lake inflow, outflow, and ET volumes
30 year daily hydrographs
stage-duration curves

Recommendations:
Performance measure: Number of stage events >17 ft
Indicator used: Daily stage hydrographs for Lake Okeechobee
Comments: Alternative 4 reduced the number of events to two; this compares favorably with Alternative 3 (three events), Alternative 2 (four events), the 2050 Base (five events) and the 1995 Base (six events).
Recommendation: Maintain this benefit to the lake.

Performance measure: Number of stage events >15 ft lasting > 6 months
Indicator and measure used: Daily stage hydrographs and similarity in duration of stage events >15 ft
Comments: Alternative 4 reduced the number of events to two; this compares favorably with Alternative 3 (three events), Alternative 2 (six events), the 2050 Base (six events), and the 1995 Base (seven events). Alternative 4 also had a median duration that was well below six months, and considerably lower than Alternative 3.
Recommendation: Maintain this benefit to the lake.

Performance measure: Number of stage events <12 ft lasting >6 months
Indicator and measure used: Daily stage hydrographs and similarity in duration of stage events <12 ft
Comments: Alternative 4 increased the number of events to six, as compared to Alternative 3 (five events). Both Alternatives compared favorably with Alternative 2 (seven events) and the 2050 Base (eight events), but Alternative 4 has a 2-fold greater frequency of events than the 1995 Base (three events). The duration of <12 ft events was considerably longer under Alternative 4 than Alternative 3.
Recommendation: Reduce the frequency and duration of <12 ft events.

Performance measure: Number of stage events <11 ft
Indicator used: Daily stage hydrographs for Lake Okeechobee
Comments: Alternative 4 increased the number of events to eight, as compared to only six events with Alternative 3. Both Alternatives compare favorably with Alternative 2 (nine events) and the 2050 Base (12 events), and Alternative 4 matches the 1995 Base

result (eight events). Despite a greater number of events in Alternative 4, the median duration is very short relative to all other events.
Recommendation: Reduce the frequency of <11 ft events.

Overall Conclusion:

While Alternative 4 does benefit the lake in terms of fewer high stage events, it results in an increased number of prolonged lows. This is not a desired feature for protection of the lake's ecological values. The lake subteam recommends a more "balanced" alternative that provides benefits both in terms of reduced high and low stage events in Lake Okeechobee.

C. Lake Okeechobee Service Area Subregion

Performance Based Comments:

The state's water supply planning goal of meeting demands in a 1-in-10-year drought, which has been incorporated as a Restudy performance goal, is not met by Alternative 4. Examination of the "Frequency of Water Restrictions" performance measure shows that the Lake Okeechobee Service Area is modeled as being under supply-side management (not all demands being met) for 11 events. A maximum of three events would be allowed in order to achieve the goal of meeting demands in a 1-in-10 year drought. In addition, one of the events lasts nine months, which is longer than the target maximum duration of seven months. In 1981 and 1982 there is a continuous period of 16 months in which not all demands were met.

The water shortage frequency of 11 events in Alternative 4 is worse than the frequency modeled in the 1995 Base in which there were ten years with water restrictions. On the other hand, these conditions were better than those of the 2050 Base, which had 15 years with restrictions. The water shortage frequency of 11 events in Alternative 4 was the same as the number of events in Alternative 1 (11 events), slightly less than the number of events in Alternative 2 (12 events) and significantly worse than the number of events in Alternative 3 (eight events).

Also of concern were the results of the Alternative 4 scenario with WCAs 2A and 2B decompartmentalized. With this additional component the number of water years with restriction would rise to 14 from the 11 modeled in Alternative 4.

In Alternative 4 the percentage of demands not met was 10% in the EAA and 12% for the rest of the Lake Okeechobee Service Area. These are the same percentages as in Alternative 3. They are also less than the percentages of demands not met for the 1995 Base (11% and 15% respectively), for the 2050 Base (22% and 23% respectively) and for Alternative 2 (15% and 15% respectively). In Alternative 4 the percentage of demands not met during five selected drought years was a much higher 18% and 16% respectively. These demands not met were higher than the 13% (EAA) and 11% (rest of LOSA) achieved in Alternative 3 and were roughly comparable to the 18% and 19% respectively that were modeled in the 1995 Base.

Maintaining existing levels of flood protection is also a goal in the Lake Okeechobee Service Area. Available performance measures that indicate whether flood protection is being maintained include peak stage difference maps and statistics on backpumping from the EAA to Lake Okeechobee contained in the EAA water budget. These measures only apply to the EAA. Both these sources indicate that flood protection in Alternative 4 has not deteriorated when compared to the 1995 Base. Higher peak stages are not observed in the EAA outside of reservoirs, STAs and environmentally managed areas. In addition backpumping to Lake Okeechobee, which occurs only when flood waters reach threatening levels, is much less in Alternative 4 than it was in the 1995 Base. A more discerning flood control performance measure is still being developed and was not available for the evaluation of Alternative 4.

Performance Measures and Indicators Used:

1. Frequency of Water Restrictions
2. Lake Okeechobee Daily Stage Hydrograph
3. Mean Annual EAA/LOSA Irrigation Demands and Demands not Met
4. Report – Monthly and Annual Supply-Side Management Results
5. Report – Cumulative Total Demand, Cutback Volume, and Cutback over Period of Simulation
6. Water Shortages by Phase and Trigger output
7. EAA and LOSA Demands – Dry Years
8. Total Irrigation Supply and Shortages for Seminole Tribe, Big Cypress Reservation
9. Lake Okeechobee Service Area Subregion Reports on Annual Demands & Demands not Met
10. C-43 & C-44 Basin Regional Irrigation Supply and Demand not Met
11. Other LOSA Supplemental Irrigation Supply and Demand not Met
12. Number of Undesirable Lake Okeechobee Stage Events
13. Peak Stage Differences (.25 ft higher)
14. Average Inflows and Outflows to Lake Okeechobee

Public Comments Received (paraphrased):

1. Gail Murray for the Seminole Tribe: A reduction in demands not met for the Big Cypress Reservation in Alternative 4 as compared to Alternative 3 was noted as were slightly higher demands not met for the Brighton Reservation. The reduced frequency at which Lake Okeechobee levels exceed 15 feet was stated as benefiting the Brighton Reservation. Clarification of the location of the removal of the L-28 levee was requested.
2. Steve Lamb for the Agricultural Coalition: Water restrictions were stated as being unacceptable. Concerns not related to specific performance measures were expressed about the feasibility of the ASR systems as modeled, and about the future demand projections.
3. Tom MacVicar for the Agricultural Coalition: Water supply performance does not meet the 1 in 10 year planning objective. Concerns not related to specific performance measures were expressed regarding the assumed performance of ASR.

D. Lower East Coast Subregion

Summary:

Alternative 4 generally worsens the ability of the regional system to meet water supply demands for the Lower East Coast when compared to Alternative 3. Alternative 4 fails to meet the 1 in 10 year water demand performance measure. Water supply restrictions caused by low local ground water levels and low Lake Okeechobee levels are too frequent. The majority of the locally triggered cutbacks in the service areas are due to just a few wellfields, i.e. low ground water levels are not affecting the entire service area. Addressing these few localized areas will enable the service areas to avoid cutbacks. A solution appropriate for the scale and cause of the local ground water levels should be developed. The number of water supply cutback events due to low Lake Okeechobee levels remain high – six events total. Low Lake Okeechobee levels and the associated water supply restrictions still need to be addressed. The saltwater intrusion criteria for the primary canals is generally met for the LECSA. This is a substantial improvement when compared to previous alternatives. In addition, flood protection in south Miami-Dade County has improved significantly.

WATER SUPPLY

Performance Based Comments:

Locally triggered watt supply cutback events were reduced to zero. The frequency of Lake Okeechobee shortage events is still too high. There were six lake-triggered cutbacks for the service area.

Performance Measures and Indicators Used:

1. Frequency and Severity of Water Restriction Triggers for the 1965-1995 Simulation Period for North Palm Beach Service Area
2. Frequency of Water Restrictions for the 1965-1995 Simulation Period – North Palm Beach County.

Recommendation:

1. The number of locally triggered events has been reduced to zero. More water needs to remain in Lake Okeechobee to avoid water supply cutbacks or perhaps how restrictions are triggered could be changed.

Subteam Issues:

Need to minimize use of ASR since it is an unproven technology and may not be effective in some areas such as Lake Okeechobee due to natural constraints (poor transmissivity of the aquifer and high organic content of the raw water), uncertainty of permitting, and risk of failure. At least two regional ASR facilities should be reduced in volume, the Lake Okeechobee and the regional Miami-Dade County facilities.

Performance Based Comments:

Only one locally triggered shortage event occurred during the period of record in Service Area 1. The frequency of shortage events caused by Lake Okeechobee is too high. There were six lake-triggered cutbacks for the service area.

Performance Measures and Indicators Used:
1. Frequency and Severity of Water Restriction Triggers for the 1965-1995 Simulation Period for Service Area 1.
2. Frequency of Water Restrictions for the 1965-1995 Simulation Period – Service Area 1.

Recommendation:
1. Deliveries to the environment could be reduced in order to ensure adequate levels are maintained in Lake Okeechobee to minimize the high number of water supply cutbacks to the LECSA or perhaps change how restrictions are triggered.

Performance Based Comments:

The frequency of water supply cutback events caused by low levels in Lake Okeechobee is too high for Service Area 2. There were six lake-triggered cutbacks for the service area. Twelve shortage events for the period of record are caused by local trigger wells. The low ground water levels triggers located near the Pompano, Hollywood, Ft Lauderdale Airport, and North Lauderdale triggers are causing the cutbacks. Hollywood and Ft Lauderdale Airport are the most problematic. Moving Hollywood′s demands west has helped some, but has not but has not solved the problem of low ground water levels in the C-10 basin. The number of months of cutbacks has been reduced from 25 in Alternative 3 to 22 in Alternative 4, but moving the water supply demand has not solved the problem. Other factors besides the amount of water pumped at the wellfield are affecting the ground water levels in the basin and triggering the restrictions. Additional conservation would not be an effective strategy to improve regional conditions.

Performance Measures and Indicators Used:
1. Frequency and Severity of Water Restriction Triggers for the 1965-1995 Simulation Period for Service Area 2.
2. Frequency of Water Restrictions for the 1965-1995 Simulation Period – Service Area 2.

Recommendation:
1. Deliveries to the environment could be reduced in order to ensure adequate levels are maintained in Lake Okeechobee to minimize the high number of water supply cutbacks to the LECSA or perhaps change how restrictions are triggered.
2. Water could be routed from the C-9 Basin to the C-10 Basin to recharge Hollywood's wellfield.
3. In addition, Pompano also currently experiences saltwater intrusion problems in its wellfields. Additional modification of the secondary canal recharge component may address this problem.

Performance Based Comments:

Seven water supply cutback events for the period of record are caused by local ground water conditions in Service Area 3. The wells with low ground water levels in Service Area 3 are located near Homestead (12 times), Florida City (one time – Phase 2), and Taylor (six times). Alternative 4 has reduced the water supply cutbacks due to low ground water levels in Cutler Ridge, N Miami, and Miami to zero. It should be noted that the Florida City trigger affects the Florida Keys Aqueduct Authority and the South Dade Water Supply System. All of the Keys and South Dade incur a Phase 2 restriction in Alternative 4. In addition, there are six Phase 1 water supply cutback events due low water levels in Lake Okeechobee.

Performance Measures and Indicators Used:
1. Frequency and Severity of Water Restriction Triggers for the 1965-1995 Simulation Period for Service Area 3.
2. Frequency of Water Restrictions for the 1965-1995 Simulation Period – Service Area 3.

Recommendation:
1. Additional mounding of ground water or increasing ground water seepage for Dade County would help. Deliveries to the environment could be reduced in order to ensure adequate levels are maintained in Lake Okeechobee to minimize the high number of water supply cutbacks to the LECSA or perhaps change how restrictions are triggered.

CANAL LEVELS

Performance Based Comments:

All canal levels meet or exceed the saltwater intrusion criteria for the North Palm Beach Service Area.

Performance Measures and Indicators Used:
1. % of time Canal Stage less than Saltwater intrusion Criteria and Occurrences greater than one Week for North Palm Beach Service Area.
2. Stage hydrographs and stage duration curves.

Performance Based Comments:

All canal levels meet or exceed the salt-water intrusion criteria for Service Area 1.

Performance Measures and Indicators Used:
1. % of time Canal Stage less than Saltwater intrusion Criteria and Occurrences greater than one Week for Service Area 1.
2. Stage hydrographs and stage duration curves.

Recommendations:
1. There may be some efficiency to be gained in the Lake Worth Drainage District. LWDD is a large user of water that could use the deliveries from the regional system and local basin runoff more efficiently by modifying its operations. This should be modeled in Alternative 5.

Performance Based Comments:

The C-9 and C-14 Canals fail to meet the saltwater intrusion criteria. Both canals experience limited drops in water levels (2% of the time), which is better than Alternative 3 yet exceeds the goal of no water levels below the saltwater intrusion criteria in the primary canals. Alternative 4 results in higher stages at S-29 over much of the wet season and a noticeable decrease in the number of saltwater intrusion trigger events relative to Alternative 3. This implies that ground water levels are slightly higher, on average, than in Alternative 3, a result that is depicted in the stage duration curves for Indicator Region 48. These results indicate that there is a slightly greater hydraulic head for this alternative that should result in slightly improved ground water deliveries to Biscayne Bay relative to Alternative 3. Additionally, the ground water stage duration curves indicate that Alternative 4 results in higher ground water stages at the very low end of the curve, which implies that ground water flows to the bay may continue to a greater degree during drought conditions under this alternative. Alternative 4 therefore shows some improvement over Alternative 3 with respect to ground water conditions in Biscayne Bay.

Performance Measures and Indicators Used:

1. % of time Canal Stage less than Salt-water intrusion Criteria and Occurrences greater than one Week for Service Area 2.
2. Stage hydrographs and stage duration curves.

Recommendation:

1. Continue current operation of C-9 to maintain or increase surface and ground water levels.

Performance Based Comments:

Flows over S-13 and S-13A are reduced by half and to zero, respectively, diminishing the amount of water able to be supplied to the Pond Apple Sough. The Slough is located just east of the Ft Lauderdale Airport. Rehydration of the Slough, a joint project by the SFWMD and Broward County – DNRP, requires additional waters to be sent east on the C-11 over the S-13. Also the stage hydrograph for the S-13A indicates that the canal dries out periodically.

Performance Indicators Used:

1. Mean wet/dry Season Flows to Pond Apple Slough through C-11@S-13 for the 31 year simulation.
2. Stage hydrographs and stage duration curves for S-13 and S-13A.

Recommendation:

1. Modify operation of the C-11 and C-9 Reservoirs to provide more flows east. Perhaps component Q4 could be modified so that when storage is not available in the Central Lake Belt Storage Area flows are sent east to Pond Apple Slough (S-13).
2. Water may be able to be routed from the North New River Canal south through the Flamingo Canal to the C-11. Operation of the pumps and structures may need to be modified to avoid the draw down of the western portion of the C-11.

Performance Based Comments:

Flows over S-33 remain constant on all runs. It has been documented by BC-DNRP that additional flows are necessary to prevent saltwater intrusion. Restoration of the North Fork of the New River is a Critical Project of the Corps and is sponsored by Broward County.

Performance Indicators Used:

1. Mean wet/dry Season Flows to North Fork of New River C-12@S-33 for the 31-year simulation.
2. Stage hydrographs and stage duration curves.

Recommendation:

1. Provide more flows east on the C-12.

Performance Based Comments:

Alternative 4 shows a significant decrease in the number of times the canals were not able to meet the saltwater intrusion criteria when compared to Alternative 3 for the C-6, C-4 and C-2. The canals fail to meet the saltwater intrusion criteria only 1%-2% of the time. This is a great improvement over Alternative 3 when the C-4 and C-2 failed to meet the criteria 27% and 21% of the time. Even though Alternative 4 results in similar stages at S-22 over much of the wet season and a noticeable decrease in the number of times the canal fails to meet the saltwater intrusion criteria during the dry season relative to Alternative 3, the stages are lower than either the 1995 Base or 2050 Base 75% of the time. Since canal stages are related to ground water levels on adjacent lands, this implies that the alternatives create lowered ground water levels relative to base conditions in this region, except under extreme dry conditions, where Alternative 4 results in higher canal stages to manage for saltwater intrusion.

Performance Measures and Indicators Used:

1. % of Time Canal Stage < Saltwater Intrusion Criteria and Occurrences >1 Week - Canal C-6 at S-26, C-4 @S-25B, and C-2@S-22.
2. Stage duration and stage hydrographs.

Recommendation:

1. Increase ground water flows.

Performance Based Comments:

Many of the South Miami-Dade County Canals water levels have shown some improvement in Alternative 4. C -100A may have an error in it since it shows canal levels over 16' NGVD. C-103 water levels have declined with respect to the 1995 Base. C-1, C-100B, C-102N, and C-103S have shown some improvement with respect to the 1995 Base. Alternative 4 results in ground water stages that are not noticeably different from Alternative 3 or the 2050 Base, except under extreme dry conditions, but which are less than 1995 Base under all conditions. The stage duration curves S-103 @ S-20F show a similar relationship, but Alternative 4 results in slightly higher canal stages than either Alternative 3 or the 2050 Base. The lack of water supply to these canals may also

result in the triggering of water shortages in South Miami-Dade. The backfilling of portions of the C-111 may have helped nearby canals.

Performance indicator:
1. Stage duration curves for C-100A, C-100B, C-102N, C-103, C-111, C-103S, C-102, and C-1.
2. Stage duration and stage hydrographs.

Recommendation:
1. Increase ground water flows.

RESERVOIRS
Performance Based Comments:

Even with addition of ASR, less water is available from the Site 1 reservoir in Alternative 3 than in Alternative 2. The reservoir is dry 30% of the time and the duration curve is much lower in Alternative 3 than in Alternative 2.

Performance Indicator Used:
1. Stage duration curves for Site 1 Reservoir.

Recommendation:
1. Maintain water levels to sustain ecological values.

Subteam Issues:

How cost effective is reservoir and ASR? Could ASR replace above ground reservoir. Also how risky is it to rely so heavily on ASR?

Performance Based Comments:

The function of the C-11 Reservoir was modified in Alternative 4 to perform as an STA.

Performance Indicator:
1. Stage duration curves for C-11 Reservoir.

Performance Based Comments:

The C-9 Reservoir is much drier when compared to Alternative 3. May be too much water is going south and west.

Performance Indicator Used:
1. Stage duration curves for C-9 Reservoir.

Recommendation:
1. Keep enough water in the C-9 Reservoir to maintain ecological values while maintaining the C-9 above the saltwater intrusion criterion at the eastern structure.

Performance Based Comments:

Operation of the Bird Drive impoundment needs to be reexamined and/or more water needs to be routed from the regional system to hold consistently higher levels in these canals. The stage duration curve exceeds ground elevation only 3% of the time, which is less often than Alternative 3. Water quality concerns have been addressed by directing flows from urban areas away from the reservoir.

Performance Indicator Used:
1. Stage duration and hydrographs for Bird Drive Reservoir.

Recommendation:
1. May need to look at the cost-effectiveness of this component.

Performance Based Comments:

The Central Lakebelt Storage described in Alternative 4 has too many demands on it. The majority of the water is received from the WCA-2B and is pumped to NESRS. Using the water to meet natural area demands is inefficient since improvements to the slough are minimal due to the limited quantity of water stored in the reservoir.

Performance Indicator Used:
1. Stage duration and hydrographs for Central Lakebelt Reservoir.

Recommendation:
1. A more efficient use of the water would be to use it to maintain stages in the Dade-Broward Levee Canal, enhance supplies to the South Dade Conveyance System or improving dry season flows to Biscayne Bay. Flows to NESRS could come directly from WCA-2B and not be stored in the Central Lakebelt Reservoir. Also, enlargement may be necessary to meet all of the demands placed on it.

DISCHARGES TO TIDE
Performance Based Comments:

For Alternative 4, there were continued decreases in discharges to tide, yet saltwater intrusion criteria is still able to be met the vast majority of the time. Discharges to tide in the North Palm Beach Service Area remain constant when compared to the 1995 Base. For Service Area 1, there is a 49% average annual decrease (399k acre-feet/yr) in discharges to tide when compared to the 1995 Base. For Service Area 2, discharges to tide decrease approximately by 16% (75k acre-feet/yr) on average compared to the 1995 Base. In the case of Service Area 3, there is a 52% decrease in discharges to tide on average (525k acre-feet/yr) when compared to the 1995 Base. The mean annual reduction in discharges to tide is 1,016,000 ac/ft.

Performance Indicator Used:
1. Mean Annual Surface Flows Discharged to Tide from the LECSA for the simulation period.

WATER DELIVERIES
Performance Based Comments:

The volume of water supplied on average has increased when compared to the 1995 Base, 2050 Base and Alternative 3 for Service Area 1 by up to 60%, increased for Service Area 2 by 200%, and increased for Service Area 3 by approximately 30%. Much of the increase in deliveries is due to increased reliance on ASR and reservoirs to supply water. There is some concern over the viability of this option when uncertainty surrounds the use of ASR. A different source of water should be found or the WCAs should be used to supply water. The NSM targets for many of the cells in Everglades National Park are exceeded, which may indicate additional water available in the regional system. During drought events, deliveries from Lake Okeechobee and WCAs have declined for Alternatives 3 and 4 when compared to Alternative 2, 1995 Base and 2050 Base. If including ASR and reservoirs, deliveries during drought events increase. During wet years, the Lower East Coast Service Areas have gained some self-sufficiency, but they are still dependent on the regional system and new sources of water during drought events. Maintaining storage areas in the regional system is the key to overcoming droughts in the LECSA. The decline in deliveries is also evidenced in the decline in flows to Biscayne Bay.

Performance Indicator Used:

1. Number of days and volume LECSA Water Supply Deliveries were made from Lake Okeechobee for the simulation period.

Recommendation:

1. Increase deliveries to Service Area 2 and 3 as needed (or increase ground water seepage).

FLOOD PROTECTION

Performance Based Comments:

Generally, the risk of flooding declines for Alternative 4 when compared to Alternative 3. The stage duration curves for R12C28 and R10C25 are near or below the target ground water levels. No additional improvement is needed in this area. For R17C27, Alternative 4 meets the target ground water level except for extreme high and low water events. Of course, the low water events do not impact the flooding potential, but do indicate some excess storage in the system. Less than 1 in 10-year flood events occur in R17C27. In R15C26 and R13C25, the stage duration curves are a significant improvement over previous alternatives in the mid to higher stages. The stage hydrographs indicate that Alternative 4 is generally wetter in the late season, but matches the 1995 Base at peaks and in the dry season. For R19C27, the stage duration curves are a significant improvement over previous alternatives in the low and high stages. The stage hydrographs indicate that Alternative 4 tends to dry off more slowly than the 1995 Base at the end of the wet season.

Performance Indicators Used:

1. Stage Hydrographs and duration curves for R10C25, R17C27, R 12C28, R13C25, R19C27 and R15C26.

Performance Based Comments:

The peak stage differences map comparing Alternative 4 to the 1995 Base indicates some improvement by reducing the number of higher peak stages. The number of cells indicating changes in peak stages 0.5 ft lower have increased when compared to the 1995 Base.

Performance Indicator Used:
1. Peak stage differences map.

E. Northern / Central Everglades (WCAs, Holey Land, Rotenberger)

Loxahatchee National Wildlife Refuge (WCA-1)

Performance Based Comments:

Since the design of Alternative 4 was based on meeting the current USFWS regulation schedule (1995 Base case) and not NSM targets as simulated under Alternative 3, the following results are not surprising. Overall, Alternative 4 hydroperiods exceed NSM targets in the southern portion of WCA-1 (Indicator Region 26), but are more similar to NSM hydroperiod targets within the north end of the Refuge (Indicator Region 27). Alternative 4 also resulted in a 10% reduction in the percent of the Refuge (84.2%) that "matches" the NSM hydroperiod target as compared to Alternative 3 (94.7%). Overall Alternative 3 is more similar to NSM with respect to water depth and hydroperiod targets, while Alternative 4 performs more similarly to the current 1995 Base case. If NSM is the desired target for WCA-1, Alternative 4 is worse than Alternative 3. However if maintaining the water regime simulated by the 1995 Base case is the desired target, Alternative 4 comes close to achieving this goal.

Performance Measures and Indicators Used:
1. Hydroperiod matches with NSM, inundation duration, stage duration curves, temporal variation in weekly stages, and high water/low water summary table for indicator regions 26 and 27.

Recommendations:
1. If NSM inundation patterns are the desired target for WCA-1, then there is a need to reduce water depths in the southern portion of WCA-1.

WCA-2A

Performance Based Comments:

Alternative 4 showed mixed results with respect to matching NSM hydroperiod targets within WCA-2A. Hydroperiods in northern WCA-2A (Indicator Region 25) under Alternative 4 (flooded 98% of the time) are considerably longer than the 1995 and 2050 Base cases, and also tend to overshoot the NSM target by 7%. Although this is an improvement relative to the base cases, Alternative 3 is a better match with NSM in northern WCA-2A. In southern WCA-2A, however, Alternative 4 (flooded 94% of the times) is a better match for NSM (flooded 94% of the time), a slight improvement over

Alternative 3 (flooded 92% of the time) and a significant improvement over the base cases.

With respect to the ability to match NSM timing of peaks and seasonal patterns of variability, dry season depths in northern WCA-2A (Indicator Region 25) for Alternative 4 exceed NSM by about 0.25 ft, whereas Alternative 3 and the base cases are more similar to NSM water depths. Like previous alternatives, Alternative 4 wet season water depths peak earlier than in NSM. Interannual standard deviations are smaller and more like NSM conditions, which is an improvement over the base cases and similar to Alternative 3.

Alternative 4 did not reduce the occurrence of extreme high water conditions. Thirteen high water (>2.5 ft) events, averaging five weeks in duration, occurred in southern WCA-2A. Alternative 4 was therefore less successful than Alternative 3 or the base cases in reducing high water events. Alternative 4 also performs worse than Alternative 3 or the base cases during extreme high water events in southern WCA-2A

Alternative 4 successfully achieved NSM low water targets throughout WCA-2A. Overall, Alternative 4 meets exceedence targets more successfully than Alternative 3 and the bases.

Performance Measures and Indicators Used:
1. Normalized Weekly Stage Hydrograph for Indicator Regions 24 and 25
2. Temporal Variation in Mean Weekly Stage for Indicator Regions 24 and 25
3. Inundation Pattern (1965-1995) for Indicator Regions 24 and 25
4. Stage Duration Curves for Indicator Regions 24 and 25
5. Stage Duration Curve at Gage 2-17
6. Number of extreme high and low water events

Recommendation:
1. Reduce hydroperiods in the northern portion of WCA-2A to meet NSM hydroperiod targets, and reduce the number of extreme high water events in the southern portion of WCA-2A.

WCA-2B

Performance Based Comments:

Average annual hydroperiod is significantly reduced under Alternative 4 (flooded 70% of the time), which is much less than NSM target of 95%. These values are also much lower than the base cases and Alternative 3. Alternative 4 water depths also average about 1.0 ft below the NSM target year round. The 1995 Base is currently the best match so far to NSM water depth patterns. The redesign of Alternative 4 to reduce water depths in WCA-2B has worked too well and exceeds the desired target.

The number of extreme high water events is also significantly reduced in Alternative 4 as compared to prior alternatives and the base cases. However, Alternative 4 has three events averaging 21 weeks in duration. This represents 4% of total period of record, which is much higher than NSM (two events averaging three weeks in duration). Alternative 4 also has 27 extreme low water events averaging six weeks duration for a total of 11% of time. This is much worse that Alternative 3 and both bases.

Performance Measures Used:
1. Stage duration curves for Indicator Region 23
2. Timing of Water Depth Variations for Indicator Region 23.
3. Number of Extreme High and Low Water events for Indicator Region 23

Recommendation:
1. The combined frequency of extreme high and extreme low water periods in Alternative 4 equals 15% of the period of record. This is much better than Alternative 3 and the base cases, but still is far from the NSM target, which experiences extreme high/low water events only 1% of time. Although Alternative 4 is the best alternative so far, hydroperiods need to be substantially lengthened to avoid the risk of increased soil oxidation and severe muck fires.

Holey Land Wildlife Management Area

Performance Based Comments:

Alternative 4 does a good job of matching NSM hydroperiod targets. This is a major improvement over the 2050 Base case, but it differs little from Alternative 3 or the 1995 Base case. Alternative 4 timing and seasonal water depth patterns are similar to the NSM and Alternative 3 as well as the 1995 and 2050 base cases. In terms of high water events, Alternative 4 exceeded 1.5 ft deep 24 times for an average of 11 weeks duration, 17% of the time. These values are identical to Alternative 3, worse than the 1995 Base case, but better than the 2050 Base case. High water levels have the potential to impact tree islands and for the short-term, promote cattail proliferation.

Alternative 4 also tends to experience extreme low conditions (i.e., fall -1.0 ft below ground) fewer times (ten events) than Alternative 3 (13 events), and is similar to the 1995 base case (11 events) and the 2050 Base case (nine events). Overall, Alternative 4 (like Alternative 3) spends 20% of the period of record under either high or low water conditions. There is a need to reduce the number of high water events without substantially increasing the frequency of low water events. NSM-like hydroperiods and timing should also be maintained.

Performance Measures Used:
1. The performance measures used were those for Indicator Regions 29 and include examination of stage duration curves, inundation duration tables, extreme high and low water events, normalized weekly stage hydrographs, and temporal variation in mean weekly stage.

Recommendation:

1. Change operations to an inflow/outflow regulation schedule, or add high/low limits to rainfall-driven operational rules. It is important to note that the 1995 Base case, which employs a regulation schedule, is best so far at minimizing combined high and low water extremes.

Rotenberger Wildlife Management Area

Performance Based Comments:

Alternative 4 does a good job of matching NSM hydroperiod targets within the Rotenberger WMA. However, for large periods of time (17% of the period of record) Alternative 4 (like Alternative 3) exhibits either extreme high or low water conditions. In terms of percent of time flooded, Alternative 4 is an improvement over the 1995 Base case (flooded 59% of the time, too short) and the 2050 Base case (flooded 86% of the time, too long). Alternative 4 (flooded 79 % of the time) is identical to both Alternative 3 and the NSM. In addition, Alternative 4 timing and seasonal water depth patterns generally match the NSM, are somewhat improved over the 1995 Base case, and are similar to Alternative 3 and the 2050 Base case.

In terms of high water events, Alternative 4 exceeded 1.5 ft deep 16 times for an average of nine weeks duration, 9% of the time. These values are identical to Alternative 3, much worse than the 1995 Base case, but better than the 2050 Base case. Alternative 4 produces frequent high water events which have the potential to flood fire-damaged tree islands and promote cattail expansion.

Alternative 4 also tends to experience extreme low conditions (i.e., fall -1.0 ft below ground) in excess of the NSM and peat soil protection targets. Alternative 4 exhibits 17 low water events below –1.0 ft below ground averaging seven weeks in duration (5% of the period of record) This is similar to Alternative 3, much improved over the 1995 Base case, but worse than the 2050 Base case.

Performance Measures Used:

1. The performance measures used were those for Indicator Region 29 and include inundation duration, extreme high and low water events, normalized weekly stage hydrographs, temporal variation in mean weekly stage and stage duration curves.

Recommendations:

1. Same as for Holey Land. Change operations to an inflow/outflow regulation schedule, or add high/low limits to the rainfall-driven plan.

WCA-3A

Performance Based Comments:

Alternative 4 matches NSM inundation duration values in northwest WCA-3A (indicator regions 20 and 22), but the hydroperiod is shorter (90% vs. NSM's 94%) in Indicator Region 20, with more, shorter periods of inundation. Both areas show

substantial improvement over 1995 and 2050 bases. Alternative 4 meets all targets in both indicator regions for extreme high water events but still exceeds NSM slightly in the number and percent time in dry-out events. This is better than 2050 Base, much better than 1995 Base, and slightly improved over Alternative 3.

Alternative 4 hydroperiod is 5% shorter than NSM .in northeastern WCA-3A (Indicator Region 21). This is a deviation in the opposite direction from the wetter 2050 Base (90%) and Alternative 3 (92%). Timing of peaks and depth pattern is similar to NSM for northeastern WCA-3A in Alternative 4 however, high water events exceed NSM values. Overall, Alternative 4 does not meet any targets for reduction in high water in northeastern WCA-3A. Extreme low water events in this area are similar to NSM in Alternative 4 but it still dries out below -1.0 ft on 17 occasions as compared to 11 occasions in Alternative3. This is better than the 1995 Base but worse than the 2050 Base. Such a large number of drying events is likely to lead to further loss of peat soils in this area.

Timing of high and low average depths in Alternative 4 is similar to NSM in eastern WCA-3A (Indicator Region 19). However, the interannual standard deviation in Alternative 4 is much larger than NSM, Alternative 3, and both bases, reflecting a tendency toward more extreme depth differences between high and low rainfall years. Alternative 4 meets none of the targets for extreme high water events in eastern WCA-3A although it is slightly improved over Alternative 3. The overall median depth exceeds NSM by about 0.6 ft. Alternative 4 has ten low water events averaging four weeks duration for 3% of total time in Indicator Region 19. This frequency is similar to NSM, but is higher than either Alternative 3 or the bases.

Hydroperiods in indicator regions 14 and 17 match NSM targets, but may be slightly too long in Indicator Region 18 (97% vs 92% for NSM). All three regions show good matches with NSM targets for timing of peaks and depth patterns. For extreme high water events, Alternative 4 is much improved over 1995 and 2050 bases as well as Alternative 3 in regions 14 and 17; Alternative 4 is equal to or slightly better than Alternative 3 and the bases in Region 18. There remain two high water events (1994 and 1995) with mean durations over 2.5 ft of 3-6 weeks. All three regions are close to NSM target values but still exceed them in event duration. Overall, seven of 15 target values for the high water criterion are met, which may be the maximum that can be achieved. The three regions have 2-4 low water events averaging 3-5 weeks. Alternative 4 has more low water events than Alternative 3 or the bases in Region 14, but fewer in regions 17 and 18.

Performance Measures Used:
(The Performance Measures used were those for indicator regions 14 and 17-22)

1. Inundation Duration. Mean hydroperiod, number of inundation events, and mean duration of inundation were compared for match with NSM values.
2. Extreme High Water (protection of tree islands, NSM flood levels). The frequency and duration of events in which depths exceeded 2.5 ft (or 2.0 ft, Indicator Region 21 only) were calculated, with a planning target of: (1) minimize and (2) be less than or

equal to NSM for each of three scores: # events; mean duration; and % of time > 2.5 ft depth
3. Extreme Low Water (protection of peat soils). The frequency and duration of events in which depths fell below -1.0 ft were calculated, with a planning target of:(1) minimize and (2) be less than or equal to NSM for each of three scores: # events; mean duration; and % of time < -1.0 ft depth.
4. Timing of high and low stages. The weeks in which annual average high water and annual average low water occurred were compared to NSM, with a planning target of matching NSM timing.

Performance Indicators Used:
1. Normalized Weekly Stage Hydrograph for indicator regions 14,17-22
2. Temporal Variation in Mean Weekly Stage for indicator regions 14,17-22
3. Inundation Pattern (1965-1995) for indicator regions 14,17-22
4. Stage Duration Curves for indicator regions 14,17-22
5. Stage Duration Curve at Gage 3A-4
6. Ponding Depth Maps
7. Ponding Depth Difference Maps
8. Peak Stage Difference Maps

Recommendations:
1. Although it may not be possible to achieve the zero event target for protection of peat soils, it should at least be possible to reduce low water events in northwest WCA-3A below NSM values (fewer than 5-6 events totaling no more than 2% of time) by increasing dry season deliveries to the area.
2. Decrease the number and duration of low water events in northeasten WCA-3A (Indicator Region 21) to protect already-impacted peat soils.
3. Decrease number and duration of high water events, to protect tree islands and wading bird nesting habitat.
4. Overall, the stage duration curve in northeastern WCA-3A needs to be less steep with a longer duration of inundation combined with fewer low water and high water extremes. This problem occurs throughout eastern WCA-3A, WCA-3B, and extends into NE Shark Slough, so a regional solution is required.
5. In south central WCA-3A, the combined percent of time for both high and low water events is much shorter in Alternative 4 (2-4% of time) than in Alternative 3 (4-5%), 2050 Base (4-6%), and 1995 Base (4-36%). Maintain current performance.

WCA-3B

Performance Based Comments:

The hydroperiod for WCA-3B (Indicator Region 15) in Alternative 4 matches the NSM target of 94%; this is an improvement over Alternative 3, which was inundated for too long (99% of time). Alternative 4's interannual standard deviation is much larger than Alternative 3, NSM, or the bases. Dry season average minimum is similar to NSM but wet season average maximum is about 0.75 ft deeper than NSM (as well as slightly deeper than Alternative 3). Alternative 4 has 18 high water events averaging eight weeks

for a total of 9% of time. This is worse than Alternative 3 and both bases. It does not meet NSM targets (six events averaging six weeks; 2% of time). Such high water would have negative ecological impacts, especially for tree islands. Alternative 4 has seven low water events averaging five weeks in duration for a total of 2% of time. This is worse than Alternative 3 and both bases and does not meet NSM targets.

Performance Measures Used:
(The Performance Measures used were those for Indicator Region 15 only)

1. Inundation Duration. Mean hydroperiod, number of inundation events, and mean duration of inundation were compared for match with NSM values.
2. Extreme High Water (protection of tree islands, NSM flood levels). The frequency and duration of events in which depths exceeded 2.5 ft were calculated, with a planning target of:(1) minimize and (2) be less than or equal to NSM for each of three scores: # events; mean duration; and % of time > 2.5 ft depth
3. Timing of high and low stages. The weeks in which annual average high water and annual average low water occurred were compared to NSM, with a planning target of matching NSM timing.

Performance Indicators Used:

1. Normalized Weekly Stage Hydrograph for Indicator Region 15
2. Temporal Variation in Mean Weekly Stage for Indicator Region 15
3. Inundation Pattern (1965-1995) for Indicator Region 15
4. Stage Duration Curves for Indicator Region 15
5. Ponding Depth Maps
6. Ponding Depth Difference Maps
7. Peak Stage Difference Maps

Recommendations:

1. WCA-3B needs to be shallower. Specific recommendations are to further reduce peak depths in northern WCA-3B, and to reduce average wet season highs in Region. 15.
2. The recommended way to achieve this is to provide appropriate and abundant conveyance of water from the conservation areas to ENP in such a manner that NSM depths can be achieved in Shark Slough without leading to excessive ponding in WCA-3B or over-drainage of WCA-3A. The combined percent of time for both high and low water events is much larger in Alternative 4 (11% of time) than in Alternative 3 (4%), 2050 Base (4%), 1995 Base (1%), and NSM (2%).
3. There is a need to reduce extreme depths substantially. This is part of the same problem that occurs throughout eastern WCA-3A and extends into NE Shark Slough, so a regional solution is required.

Pennsuco Wetlands

Performance Based Comments:

Alternative 4's hydroperiod of 84% is similar to NSM (87%) and improved over Alternative 3 (93%) and both bases (81%). The stage duration curve for Alternative 4 is

overall more similar to NSM with respect to median, low and high depths, than is Alternative 3 or the 1995 or 2050 bases. However, median depths and wet season high water exceeds NSM by 0.2 to 0.4 ft, approximately, while dry-outs are more severe than NSM by about 0.4 ft.

Recommendations:
1. Reduce extremes of high and low water.

Overall Northern and Central Everglades Landscape-level Evaluation

Performance Based Comments:

Under Alternative 4, dry season ponding is improved (i.e., not as patchy) as compared to Alternative 3. Shark River Slough and Taylor Slough also show better dry season drying patterns under Alternative 4 as compared to Alternative 3. In WCA-3, Alternative 4 shows better signs of ecosystem "connectivity" (the eastern boundaries are slightly deeper and show signs of being more of a contiguous body of water) as compared to Alternative 3. In WCA-2B, abnormally high water conditions experienced during the dry season under Alternative 3 were significantly reduced under Alternative 4. In contrast, Alternative 4 produces significantly drier conditions in the northern portion of WCA-1 as compared to Alternative 3.

Wet season ponding under Alternative 4 exhibited improved spatial patterns of inundation. There is no longer deep water accumulating along the southern portion of WCA-3A (as experienced in Alternative 3), with deeper water being confined primarily the eastern edge of WCA-3A. In addition, wet season ponding under Alternative 4 is not as deep as experienced under Alternative 3.

A dramatic landscape pattern emerges from Alternative 4 that was not apparent in previous alternatives - the development of a large deep water, long hydroperiod zone in NW central WCA-3A. This deep water "ponded" area creates a more patchy system than was evident in Alternative 3. It should be noted that the northern gap of the L-28 tie back levee already has experienced cattail invasions. Increased water depths in this area could exacerbate this problem.

Overall, Alternative 4 resulted in a general increase in average annual hydroperiods within the Everglades with the exception of northern WCA-1 and within WCA-2B (this may or may not be a problem). In the southern portion of ENP, average annual hydroperiods show a big improvement over Alternative 3 and may benefit flows directed toward Florida Bay. On the negative side, hydroperiod maps indicate that WCA-3B has less "water-days" than either WCA-3A or Shark Slough. In addition the northern regions of WCA-3A are still hydrologically patchy and drier than they should probably be.

Performance Measures and Indicators Used:
1. Average Annual Hydroperiod maps

2. End of the dry season (May) average annual hydroperiod maps, hydroperiod maps for a major drought period (1989)
3. Average annual surface water ponding maps
4. End of the dry season (May) average annual surface water ponding maps, surface water ponding maps for a major dry period (1989);

Recommendations:
1. At the landscape level, Alternative 4 provided a number hydrological improvements to the central and southern Everglades system with better dry season drying patterns, better wet season flooding patterns, and more 'connectivity" between areas. Alternative 4 however, produced some undesirable effects such as increased drying in northern WCA-1, a new deep water, long-hydroperiod area in NW central WCA-3A, and fewer days of flooding in WCA-3B as compared to WCA-3A and SRS.
2. A number of hydrological improvements still need to be made. These include improved hydroperiods in northern WCA-1, and the northern regions of WCA-3A which are still hydrologically patchy and drier than they should be. In addition, the new deep water, ponded area in the NW central portion of WCA-3A needs to be evaluated to determine whether this is the desired restoration goal for this area of the Everglades.

F. Southern Everglades (Everglades National Park, Model Lands)

Performance Based Comments:
Northeast Shark Slough

Alternative 4 produced lower stages than NSM and stages that are less than or equal to Alternative 3 stages. Average annual overland flows to NESRS are lower than NSM in the dry season and equal to NSM in the wet season. Under Alternative 4, the number of dry downs in NESRS is six times greater than predicted by NSM. This frequency of dry downs in the heart of the historic Shark Slough will continue to demonstrably lower standing crops and alter community composition of fishes and aquatic invertebrates and to cause loss of peat soils. Melaleuca expansion will continue to progress westward into the slough because of overdrainage that results in shorter hydroperiods.

Minimum water levels under Alternative 4 occur with higher frequency than under NSM. Under Alternative 4, wet season stage (Indicator Region 11) approaches NSM, similar to Alternative 3, but falls short of NSM during the dry season, perhaps a result of either insufficient water storage upstream or lack of dry season seepage control.

Performance Measures and Indicators Used:
1. Normalized Stage Duration Curve at NESRS-2 (R21, C24)
2. Average Annual Overland Flow south of Tamiami Trail, east of L-67E
3. Average Monthly Overland Flows South of Tamiami Trail, East of L-67 Ext.
4. Peak Stage Difference 0.5 ft lower than NSM
5. Inundation Duration (# of Events) (Indicator Region 11)

6. Temporal Variation (Standard deviation) in Mean Weekly Stage for NE Shark Slough (Indicator Region 11)

Recommendations:
1. Increase the amount of upstream storage, sufficient to restore NSM-like conditions in Northeast Shark Slough.
2. Capture wet season flows along the eastern protective levee that are higher than NSM and store in a reservoir in the Lake Belt for release to Everglades National Park during the dry season.
3. Reduce the number of dry downs by incorporating seepage control strategies, such as buffer lands or maintaining higher dry season groundwater levels east of the protective levee.

Performance Based Comments:
Shark River Slough

In a dry year, NSM predicts a persistent pool aligned along the main stem of the historic Shark Slough in accordance with natural topographic contours. The cessation of sufficient overland flow into Shark Slough has resulted in the reduction or elimination of persistent pooling, as well as increased frequency of dry downs, affecting survival and productivity of aquatic organisms. Hydroperiods predicted by Alternative 4 were close to NSM, but flows were consistently lower, as in Alternative 3. Stage duration curves at five hydrological stations throughout Shark Slough showed consistently lower stages in Alternative 4 compared with NSM. Similarly, Alternative 4 resulted in about twice as many drydown events compared with NSM during the 31-year simulation period at three indicator regions in Shark Slough.

For Indicator Region 10, the number of weeks water depths exceed 2.5 ft is about four times as great under NSM as in Alternative 4, whereas the number of weeks that depths are lower than -1 ft is 14 times greater under Alternative 4 than NSM. Alternative 4 has lower natural variability in hydropatterns than under NSM. In SW Shark River Slough (Region 9) water depths are close to NSM targets and lower than in Alternative 3. Temporal Stage Variation Curves (Indicator Region 9) indicate that water depths in Alternative 4 were lower during the dry season as compared with NSM, whereas wet season depths were similar to NSM. In New Shark River Slough (Indicator Region 12) Stage Duration Curves indicate that hydroperiods for Alternative 4 are improved over Alternative 3, but fall short of NSM.

Average monthly and annual overland flows to ENP show lower volumes of water going south of the Tamiami Trail under Alternative 4 when compared with Alternative 3 and NSM. Under Alternative 4, flows west of the L-67 extension canal were similar to NSM flows during the dry season, but were less than NSM during the wet season.

Performance Measures and Indicators Used:
1. Stage Duration Curves NP-201, P-33, G-620, NP-34, NP-38
2. Average Monthly Overland Flows south of Tamiami Trail, West of L-67 Ext.

3. Normalized Weekly Stage Duration Curves for Mid Shark River Slough (Indicator Region 10)
4. Inundation Summary Table (# of events) (Indicator Regions 9, 10, 12)
5. Temporal Variation (std. dev.) in mean weekly stage for Shark Slough (Indicator Regions 10, 12)

Recommendation:
1. Increase storage capacity north of the Everglades Protection Area in order to produce stages and persistent dry season pools that closely match NSM.

Performance Based Comments:
Marl Lands West of Shark River Slough (Indicator Region 46)

Under Alternative 4, stage duration is consistently lower than predicted by NSM, with a similar number of dry-down events, which is an improvement over Alternative 3. Water depths were close to NSM and were lower than in Alternative 3. These lower water levels should be an improvement for the western sub-population of Cape Sable Seaside Sparrows.

Performance Measures and Indicators Used:
1. Stage Duration Curves for Marl Lands West of Shark River Slough, Gage NP-34
2. Inundation Summary Table (# of events) (Indicator Region 46)

Performance Based Comments:
Rocky Glades/Eastern Marl Prairies

Although Alternative 4, like Alternative 3, provided some improvement over the various base alternatives, it fell significantly short of restoration targets when compared with NSM. For example, at gage G-596, NSM predicts flooding of the area for 75% of the simulation period, whereas Alternative 4 shows almost no surface water for the same period. In addition, average annual hydroperiods under Alternative 4 showed an improvement over Alternative 3. However, in an average year (1991), hydroperiods were equal to NSM in the south, but less than NSM in the north. Ponding depth differences indicate no difference between Alternative 4 and NSM; however, stage duration curves are not in agreement with this output. Subsurface water levels during the dry season are significantly lower than predicted for NSM; this has serious consequences for solution hole refugia. Under NSM, temporal variability in stage at the beginning of the wet season is greater than that seen under the alternatives.

Restoration needs to provide longer continuous hydroperiods, greater ponding depths, and more frequent occurrence of multi-year continuous inundation.

Performance Measures and Indicators Used:
1. Marsh Stage Duration Curves (G-596, G-1502, Indicator Region 8)
2. Temporal Variation in Mean Weekly Stage for Rockland Marl Marsh (Indicator Region 8)
3. 1991 Hydroperiod differences

Recommendations:
1. Increase the inflow to the Rocky Glades, especially during the dry season.

Performance Based Comments:
Taylor Slough

There are no differences in ponding depths or average annual hydroperiods between Alternative 4 and NSM, except along the L-31 canal, where they were less than NSM. We question the reliability of NSM output for Taylor Slough. In indicator regions 1 and 3 the temporal patterns in mean weekly stage and in the variability of those stages are less than NSM.

Performance Measures and Indicators Used:
1. Stage duration curves at Taylor Slough Bridge (Gage THSO)
2. Temporal variation in mean weekly stage for Taylor Slough (Indicator Region 1)
3. Normalized weekly stage duration curve for mid Perrine Marl Marsh (Indicator Region 3)
4. Temporal variation (std. dev.) in mean weekly stage for Indicator Region 3

Recommendation:
1. Available output for Taylor Slough indicates that more water is needed during the dry season.

Note: The output provided for Taylor Slough was not adequate for the subteam to make a complete assessment of the alternative. Models runs for more stations within Taylor Slough are needed.

Performance Based Comments:
C-111 Basin

Alternative 4 has improved the hydropattern of the area, in that the frequency of dry-down events is similar to NSM. However, the weekly stage duration curve for Indicator Region 4 shows consistently greater stages than predicted by NSM. Conversely, stage duration curves at Gage G1251 showed stages consistently lower than NSM, perhaps because of canal drainage. In Indicator Region 47 there is an increase in wet season water depths in most years, which is desirable, but the wet season levels exceed the high water target approximately 7% of the time. In Indicator Region 47 there is a reduction in the number of events where low water targets are exceeded. The additional water moving into Region 47 via the C-111N moves the hydroperiod closer to the nine months desired in a marl prairie.

Performance Measures and Indicators Used:
1. Normalized Weekly Stage Duration Curves (Indicator Region 4)
2. Stage Duration Curve (G-1251)
3. Peak Stage Difference 1.0 ft higher than NSM
4. Temporal variation (std. dev.) in mean weekly stage for C-111
5. Perrine Marl Marsh (Indicator Region 4)

Recommendations:

1. Sheetflow must be reestablished in the C-111 Basin, including filling in canals, ditches, and culvert pools to reduce colonization opportunities by exotic organisms, and to eliminate artificially large, deep-water habitats that result in changes in species composition and energy flow in the adjacent wetlands.

Recommendations from Miami-Dade County DERM:

2. The Model Lands Biology Team requested that the ADT extend the C-111 North Canal into the Model Lands and connect it with the Model Lands South canal in Alternative 5. The request is to study whether this modification would move more water out of Indicator Region 4, where depths are often too high and into Indicator Regions 5 and 6, where more water would be beneficial.

Performance Based Comments:

Model Lands

Alternative 4 shows definite improvement for stage duration curves over base conditions and Alternative 3 in Model Lands South (Indicator Region 5). Alternative 4 shows a reduction from Alternative 3 in the number of wet season reversals and an increase in the hydroperiod for some years during the period of record. Stages in the northern Model Lands (Indicator Region 6) are much less than stages under NSM. Stages in the southern Model Lands (Indicator Region 5) are less than NSM at high stages, but greater than NSM at low stages. Average annual hydroperiod differences are equal to NSM in the south (Indicator Region 5) but less than NSM in the north (Indicator Region 6). Under Alternative 4, Indicator Region 6 has twice as many dry-down events as NSM. These dry downs would have significant negative effects on aquatic organisms and associated ecological processes.

The basin is closed and ecologically degraded, lacking connection with adjacent wetlands to the west. The significant reduction in spatial extent of the historic natural system requires that efforts be made to restore these wetlands.

Performance Measures and Indicators Used:

1. Stage Duration Curves for Model Lands South (Indicator Region 5) and North (Indicator Region 6)
2. Stage Duration Curves (R8, C29)
3. Peak Stage Difference 0.5' lower than NSM
4. Temporal Variation in Mean Weekly Stage Model Lands North (Indicator Region 6)
5. Inundation Summary Table (#of events) (Indicator Region 6)

Recommendation:

1. Explore strategies to improve the timing and distribution of water deliveries to the Model Lands. Decompartmentalize within the Model Lands.

Recommendations from Miami-Dade County DERM:

2. DERM recommends that careful thought be given to ways to modify the extreme water levels in Perrine Marl Marsh (Indicator Region 4) without significantly

reducing the total annual volume of water that enters the area. The Biscayne Bay Design Team is developing a regional project design, which is still in draft form, that includes elements which address providing some surface water to the Model Lands. The team recommends that a pump station be added to the cell at R11 C29 for Alternative 5, in order to model the outcome of pumping available water south to the Model Lands. The Florida City canal would be the source for water being pumped.

General Comments on Alternative 4 for the Central and Southern Everglades:

Alternative 4 was a partial decompartmentalization alternative, in which internal canals were filled in and levees were degraded in the southern part of the system. The subteam evaluated the hydrological effects of the alternative, and although the team was unable to evaluate the ecological output, the subteam predicts that ecological benefits will result from this decompartmentalization. Alternative 4 produced hydrological conditions that approached NSM closely in some areas and in certain parameters, but the subteam continues to observe problems in dry season stages and the increased frequency of drydown events that deviated from NSM. The subteam attributes the lack of concordance with NSM to insufficient flows from areas north of the Southern Everglades. The subteam strongly endorses complete decompartmentalization of the Everglades Protection Area in Alternative 5, with sufficient water supply to ensure that NSM targets are met in the southern part of the system.

Note: In the 1984 memorandum that introduced the 7-Point Plan proposed by Everglades National Park, the major recommendations for hydrologic restoration of the Shark Slough Basin included the degradation of levees and filling of canals, establishment of a rainfall-driven system, and the reestablishment of sheetflow. The ecological benefits of these hydrological actions included: (1) the reestablishment of connections between isolated basins to permit movement by aquatic animals, thereby reducing the isolation of populations; and (2) filling in canals and ditches to reduce colonization opportunities by exotic organisms, and to eliminate artificially large, deep-water habitats that result in changes in species composition and energy flow in the adjacent wetlands.

Note: A general assessment of Alternative 4, like Alternative 3, indicated that a number of structures (e.g., curtain walls and new structures) have been added. Some progress was made toward decompartmentalization of the system, but many structures and canals are still present in the model for the Everglades Protection Area and the C-111 and Model Lands areas. More effort should be made to fill canals and ditches and to remove levees whenever possible.

Recommendation:

1. Alternative 4 advanced the cause of ecological restoration that has been advanced by the Southern Everglades DOI team. Alternative 5 should represent the complete ecological restoration that will include decompartmentalization of the entire Everglades Protection Area. Alternative 5 should include the estimation of the ecological water supply needed to achieve restoration.

G. Estuaries and Bays

For the Caloosahatchee and St. Lucie estuaries and Lake Worth Lagoon, please see the subteam's highlights report.

Performance Based Comments:
Florida Bay and Coastal Basins
Stage/Salinity Relationships

In comparison to Alternative 3, Alternative 4 had a negative influence on salinity in the coastal basins of Florida Bay, as simulated by salinity/P33 stage regressions. The frequency of undesirable high-salinity events increased slightly, and the frequency of desirable low-salinity events decreased slightly.

P33 stages above 6.3 ft msl correspond to a reduced frequency of undesirable high salinity events in the coastal basins of Florida Bay. There are approximately 53 months of the period of record when NSM4.5 exceeds that stage, but Alternative 4 does not, which is less desirable than the 48 months in Alternative 3 (Table 2). These events occurred in the November-May dry season during 33 months over 22 years, and in the June- October wet season during 20 months over 13 years of the 31-year period of record.

P33 stages above 7.3 ft msl correspond to an increased frequency of desirable low salinity events in the coastal basins of Florida Bay. There are approximately 18 months of the period of record when NSM4.5 exceeds that stage, but Alternative 4 does not, which is less desirable than the 16 months in Alternative 3 (Table 3). These events occurred in the November-May dry season during five months over four years, and in the June-October wet season during 13months over eight years of the 31-year period of record.

Alternative 3 resulted in deficiencies in 6.3+ and 7.3+ ft stages at P33 most frequently during the dry season months of January and February and the wet season months of June-August (Table 4).

Indicator Region 8, Rockland Marl Marsh

The rockland marl marsh indicator region represents the higher elevation marshes in the marl prairie/rocky glades landscape. This indicator region has been chosen for detailed analysis of performance measures for the watershed for NE Florida Bay because it provides a potential hydrologic linkage between Shark River and Taylor Sloughs and a water head that potentially influences the hydrology of lower elevation marl marshlands and Taylor Slough. Hydrologic performance measures for the ecological restoration of the marl prairie/rocky glades landscape include duration of flooding during periods of standing water, maximum water depth below the ground surface during dry periods, and mean water depth > 6 inches during periods of standing water.

Duration of Flooding: Alternative 4 shows a small improvement over Alternative 3 regarding the duration of flooding performance measure. The rockland marl marsh indicator region experienced periods of flooding that averaged 8.6 months in duration under Alternative 4, compared to 8.0 months under Alternative 3 and 10.6 months under

NSM (Table 5). Two factors contributed to the two-month deficiency in comparison to NSM. During typical wet season/dry season cycles, the marsh generally flooded in the same month of the wet season in Alternatives 4 and 3 and the NSM, but the marsh tended to go dry 1-3 months earlier in the dry season in Alternatives 4 and 3 compared to the NSM. Prolonged periods of flooding of 17-33 months, as simulated by the NSM four times in the period of record, were broken by dry periods during one of the four events under Alternative 4 compared to two of the four events under Alternative 3.

Maximum Water Depth Below Ground During Drought: The performance measure of maximum water depth below ground during drought has been achieved in both Alternatives 3 and 4. The maximum water depth below the ground surface during dry conditions averaged 2.0 ft (max = 3.6 ft) under Alternative 4, 2.2 ft (max = 3.8 ft) under Alternative 3, and 2.0 ft (max = 3.9 ft) under NSM (Table 6). Both Alternatives 3 and 4 are very close to NSM regarding maximum water depth below ground during drought

Water Depth > 6 Inches During Periods of Flooding. The performance measure of water depth > 6 inches during periods of flooding has been achieved in both Alternatives 3 and 4. Alternatives 3 and 4 indicate average water depths of 0.6 and 0.7 ft during periods of flooding compared to 0.7 ft under NSM (Table 5).

Indicator Region 11, NE Shark River Slough (NESRS)

Northeast Shark River Slough is analyzed in relation to the Florida Bay coastal basins and mangrove estuaries because the hydrology of NESRS influences hydropattern in both at P33 and the rockland marl marsh. NESRS dries out 11 times in Alternative 4 and nine times in Alternative 3 compared to only one time under NSM during the period of record (Table 8). This reduces the 288 and 78 month durations of the two flood events under NSM to average durations of 28 months in Alternative 4 and 35 months in Alternative 3 (Table 7). The excessive number of drydown events in Alternatives 3 & 4 commenced most often during April (Table 8). The mean depth during flooding is also reduced by approximately 0.5 ft under Alternatives 3 & 4 compared to NSM (Table 7). Hydropattern deficiencies at P33 and the rockland marl marsh are partly attributable to the above deficiencies in NESRS.

Indicator Region 3, Mid Perrine Marl Marsh

The Mid Perrine Marl Marsh is analyzed because its hydrology should directly influence salinity regimes in the easternmost coastal basins of Florida Bay. Mean duration of flooding in this region of approximately seven months under Alternative 4 and Alternative 3 are one month shorter than the eight month duration under NSM (Table 9). The shorter duration of flooding results from the marsh drying one month earlier in the dry season. Dry conditions commence mostly during December-February under ALTS3&4 compared to January-March under NSM (Table 10). Mean depths above ground during periods of flooding of 0.5 ft under both alternatives are similar to NSM and achieve that performance measure (Table 9). Maximum depths below ground during dry periods drop to an average of 1.8 ft under both alternatives compared to 2.1 ft under NSM, indicating that the performance measure is more than achieved (Table 10).

Recommendations for Florida Bay and Coastal Basins:

P33 stages that are required for desired salinity regimes in the coastal basins more deficient in Alternative 4 than in Alternative 3. Future alternatives should concentrate on maintaining higher stages at P33 via larger water deliveries into NE Shark River Slough in the mid-to-late dry season, particularly during January and February, and in the early- to middle wet season during June-August.

The mean duration of flooding in the rockland marl marsh indicator region remains two months shorter under Alternative 4 than under NSM. Future alternatives should increase periods of flooding by an average of two months by extending hydroperiods further into the dry season, particularly during January and February, and by restoring the multi-year period of flooding during 1979-80 that occurs under NSM but is broken by dry conditions under Alternative 4.

Recommendations:

1. Reduce the number of dry events in Northeast Shark River Slough indicator region from the 9 to 11drydowns under Alternatives 3 & 4 to no more than one drydown as indicated by NSM for the period of record. Accomplish this by extending hydroperiod into the dry season through April, even during most of the low-rainfall years.
2. The mean duration of flooding in the mid Perrine marl marsh indicator region remains one month shorter under Alternatives 3 & 4 than under NSM. Future alternatives should increase periods of flooding by an average of one month by extending hydroperiods further into the dry season, particularly during January or February.

Analysis of Model Outputs

Table 1
Percent Stage Duration Of 6.3 & 7.3 ft MSL at Gage P33 During Period of Record.

P33 STAGE 6.3+ FT MSL		P33 STAGE 7.3+ FT MSL	
NSM	70%	NSM	13%
ALT4	58%	ALT4	9%
ALT3	58%	ALT3	9%
ALT2	54%	ALT2	6%
ALT1	50%	ALT1	4%
STRTPT	57%	STRTPT	7%
50BASE	42%	50BASE	1%
95BASE	34%	95BASE	1%

Table 2
Periods When a P33 Stage of 6.3 ft MSL was Attained by NSM, but not by Alt 4.

1965	JAN, MAR

1966	MAR		
1967	MAR	JUN-JUL	
1968	FEB		
1969			
1970			
1971	JAN	SEP	
1972		JUN	
1973	JAN-FEB	AUG-SEP	DEC
1974	JAN	AUG	
1975	JAN-FEB	AUG	
1976	FEB		
1977	JAN	AUG-SEP	
1978	JAN-FEB	JUN	
1979	MAR-MAY	JUN-AUG	
1980			
1981	JAN		
1982	JAN	JUN	
1983			
1984	APR-MAY		DEC
1985	JAN		
1986	APR	JUN	
1987	FEB		
1988	FEB	JUL	NOV
1989			
1990		AUG, OCT	NOV-DEC
1991			
1992	APR		
1993			
1994	MAR	JUL	
1995			

Table 3
Periods When a P33 Stage Of 7.3 ft MSL was Attained by NSM, but not by Alt 4

1965		
1966	JUL	NOV-DEC
1967	OCT	
1968	JUL	NOV
1969	JUL-SEP	
1970	SEP-OCT	
1971		
1972		
1973		
1974		
1975		
1976		

1977			
1978			
1979			
1980	JAN		
1981		OCT	
1982			
1983		JUN & AUG-SEP	
1984			
1985			
1986			
1987			
1988			
1989			
1990			
1991			NOV
1992		JUL	
1993			
1994			
1995			

Table 4
Seasonal Distribution of Stage Deficiencies at P33, when Water Levels Were Below 6.3 and 7.3 ft MSL in the 2x2 Model, but Above 6.3 and 7.3 ft MSL in NSM

	6.3 ft MSL Deficiencies	7.3 ft MSL Deficiencies	Total #
Jan	1965, 71, 73, 74, 75, 77, 78, 81, 82, 85	1980	11
Feb	1968, 73, 75, 76, 78, 87, 88		7
Mar	1965, 66, 67, 79, 94		5
Apr	1979, 84, 86, 92		4
May	1979, 84		2
Jun	1967, 72, 78, 79, 82, 86	1983	7
Jul	1967, 79, 88, 94	1966, 68, 69, 92	8
Aug	1973, 74, 75, 77, 79, 90	1969, 83	8
Sep	1971, 73, 77	1969, 70, 83	6
Oct	1990	1967, 70, 81	4
Nov	1988, 90	1966, 68, 91	5
Dec	1973, 84, 90	1966	4

Table 5
Approximate Duration of Flooding (Months) and Depth During Flooding (ft) for Each Flood Event During the 1965-1995 Period Of Record in the Rockland Marl Marsh Indicator Region 8*

NATURAL SYSTEM MODEL			ALTERNATIVE 3			ALTERNATIVE 4		
Start dates of Flood Events	Months	Mean Depth	Start Dates of Flood Events	Months	Mean Depth	Start Dates of Flood Events	Months	Mean Depth

Sep 65	6.0	0.5	Aug 65	5.8	0.6	Sep 65	5.6	0.6
Jun 66	10.4	1.0	Jun 66	8.8	0.9	May 66	8.7	0.9
Jun 67	9.4	0.7	Jun 67	8.4	0.7	Jun 67	8.4	0.7
May 68	33.2	1.0	May 68	10.4	0.9	May 68	11.6	0.9
			May 69	11.6	1.0	May 69	20.8	1.0
			May 70	7.0	0.9			
May 72	9.2	0.5	May 72	8.0	0.5	May 72	7.6	0.6
Aug 73	5.6	0.4	Aug 73	3.8	0.4	Jul 73	3.9	0.4
Jun 75	6.8	0.6	Jun 75	6.2	0.6	Jun 75	6.2	0.6
May 76	8.4	0.7	May 76	7.6	0.6	Jun 76	7.4	0.7
Aug 77	7.6	0.4	Aug 77	5.2	0.4	Aug 77	5.3	0.4
Jun 78	9.4	0.7	Jun 78	8.0	0.6	Jun 78	8.1	0.6
Apr 79	21.6	0.7	Apr 79	10.8	0.3	Aug 79	11.1	0.5
			Jun 80	6.4	0.4	Jun 80	6.5	0.5
Aug 81	5.4	0.9	Aug 81	4.4	0.9	Aug 81	4.4	0.8
Jun 82	22.2	0.7	May 82	20.0	0.8	May 82	19.8	0.7
May 84	7.2	0.6	May 84	6.1	0.4	May 84	6.0	0.6
Jul 85	9.3	0.6	Jul 85	7.0	0.6	Jul 85	7.4	0.6
Jun 86	5.9	0.5	Jun 86	5.0	0.4	Jun 86	5.0	0.5
Aug 87	5.7	0.5	Aug 87	5.2	0.5	Aug 87	4.8	0.4
May 88	5.9	0.7	May 88	5.6	0.7	Jun 88	5.3	0.7
Jul 90	4.6	0.5	Jul 90	4.3	0.3	Jul 90	4.8	0.4
May 91	11.5	0.8	May 91	9.6	0.8	May 91	9.7	0.8
May 92	10.9	0.8	Jun 92	8.7	0.8	Jun 92	10.4	0.8
May 93	10.7	0.7	May 93	8.0	0.6	May 93	8.3	0.6
Jul 94	17.0	1.1	Aug 94	16.5	1.2	Jul 94	17.0	1.2
Mean	10.6	0.7		8.0	0.6		8.6	0.7

(* Flooding events of less than three months are not included.)

Table 6
Approximate Duration of Drying (Months) and Depth Below Ground Surface (ft) for Each Dry Event During the 1965-1995 Period of Record in the Rockland Marl Marsh Indicator Region 8

NATURAL SYSTEM MODEL			ALTERNATIVE 3			ALTERNATIVE 4		
Start Dates of Dry Events	Months	Max Depth	Start Dates of Dry Events	Months	Max Depth	Start Dates of Dry Events	Months	Max Depth
Feb 65	7.0	3.3	Jan 65	8.2	3.3	Jan 65	8.1	3.0
Mar 66	2.4	0.9	Feb 66	3.4	1.5	Feb 66	3.2	1.3
Apr 67	2.6	1.9	Feb 67	4.2	2.7	Feb 67	3.7	2.3
Mar 68	2.0	1.8	Feb 68	3.0	2.3	Feb 68	2.3	2.5
			Mar 69	2.6	0.6	Apr 69	0.9	0.2
			May 70	0.4	0.2			
Jan 71	16.2	3.6	Dec 70	17.6	3.8	Jan 71	16.8	3.6
Feb 73	5.6	2.3	Jan 73	6.8	2.8	Jan 73	5.8	2.7
Jan 74	17.6	3.1	Nov 73	19.2	3.1	Nov 73	18.9	3.2
Dec 75	5.2	2.7	Dec 75	5.4	3.6	Jan 76	5.1	3.3
Jan 77	6.2	2.3	Jan 77	7.2	2.7	Jan 77	6.7	2.7

Mar 78	2.8	0.7	Jan 78	5.2	1.1	Jan 78	4.9	0.8
Mar 79	1.4	1.1	Feb 79	2.4	2.1	Feb 79	2.3	2.0
			Mar 80	3.6	1.1	Mar 80	2.7	0.7
Jan 81	6.5	3.1	Jan 81	7.4	3.2	Jan 81	7.4	3.3
Jan 82	4.4	1.4	Dec 81	5.2	1.9	Dec 81	5.1	1.8
Apr 84	1.5	1.1	Jan 84	4.1	2.3	Jan 84	3.9	2.0
Dec 84	6.7	2.8	Nov 84	7.8	3.1	Nov 84	7.7	3.2
Apr 86	1.8	1.1	Jan 86	4.1	1.7	Feb 86	3.7	1.5
Dec 86	8.7	1.7	Oct 86	9.6	2.0	Nov 86	9.4	2.0
Feb 88	3.7	2.4	Jan 88	4.3	2.7	Jan 88	4.4	2.8
Nov 88	20.0	3.9	Nov 88	20.6	3.5	Nov 88	19.7	3.5
Dec 90	4.8	2.9	Nov 90	5.2	2.4	Nov 90 `	5.6	2.3
Apr 92	1.5	1.1	Feb 92	3.3	1.9	Mar 92	3.2	1.7
Apr 93	0.6	0.3	Feb 93	3.0	1.1	Apr 93	0.9	0.5
Mar 94	4.1	0.7	Jan 94	6.8	0.7	Jan 94	5.4	0.3
Mean	5.8	3.9		6.6	3.8		6.3	3.6

Table 7
Approximate Duration of Flooding (Months) and Depth of Flooding (ft) for Each Flood Event During the 1965-1995 Period of Record in the NE Shark River Slough Indicator Region 11

NATURAL SYSTEM MODEL			ALTERNATIVE 3			ALTERNATIVE 4		
Start dates of Flood Events	Months	Mean Depth	Start Dates of Flood Events	Months	Mean Depth	Start Dates of Flood Events	Months	Mean Depth
Jan 65	288.5	1.7	Jan 65	72.1	1.7	Jan 65	72.3	1.8
			May 71	22.4	1.3	Jun 71	21.9	1.2
			Jun 73	10.2	1.2	Jun 73	9.0	1.0
			Jun 74	10.2	1.2	Jun 74	9.9	1.2
			May 75	22.8	1.3	May 75	22.4	1.3
			May 77	47.2	1.4	May 77	47.3	1.4
			Jun 81	45.7	1.6	Aug 81	8.1	1.4
						May 82	33.7	1.8
			Jun 85	44.6	1.4	Jun 85	34.4	1.4
						May 88	8.5	1.2
Jun 89	78.1	1.9	Jun 89	10.4	0.7	Jul 89	6.7	0.5
			May 90	**67.5**	**1.9**	**May 90**	**67.3**	**1.9**
Mean	183.3	1.8		35.3	1.4		28.4	1.3

Table 8
Approximate Duration of Drying (Months) And Depth Below Ground Surface (ft) for Each Dry Event During the 1965-1995 Period of Record in the NE Shark River Slough Indicator Region 11

NATURAL SYSTEM MODEL			ALTERNATIVE 3			ALTERNATIVE 4		
Start Dates of Dry Events	Months	Max Depth	Start Dates of Dry Events	Months	Max Depth	Start Dates of Dry Events	Months	Max Depth
			Apr 71	1.9	0.9	Apr 71	2.1	0.9

			Apr 73	2.3	1.1	Apr 73	2.3	1.5
			Apr 74	1.4	0.5	Mar 74	3.0	1.5
			Apr 75	1.4	0.5	Apr 75	1.2	0.4
			Apr 77	0.5	0.1	Apr 77	0.9	0.4
			Apr 81	2.1	0.6	Apr 81	3.9	1.0
						Apr 82	1.4	0.3
			Apr 85	2.1	0.5	Mar 85	3.2	1.3
						Apr 88	0.9	0.4
May 89	1.4	0.9	Mar 89	3.7	0.6	Feb 89	5.1	1.8
			May 90	0.2	0.1	Feb 90	3.5	0.6
Mean	1.4	0.9		1.7	0.5		2.5	0.0

Table 9
Approximate Duration of Flooding (Months) and Depth of Flooding (ft) for Each Flood Event During the 1965-1995 Period of Record in the Mid Perrine Marl Marsh Indicator Region 3

NATURAL SYSTEM MODEL			ALTERNATIVE 3			ALTERNATIVE 4		
Start Dates of Flood Events	Months	Mean Depth	Start Dates of Flood Events	Months	Mean Depth	Start Dates of Flood Events	Months	Mean Depth
Sep 65	5.8	0.4	Sep 65	5.3	0.4	Sep 65	5.6	0.4
May 66	9.3	0.7	May 66	6.9	0.7	May 66	7.1	0.7
Jun 67	9.0	0.5	Jun 67	7.6	0.4	Jun 67	6.9	0.5
May 68	23.4	0.8	May 68	11.1	0.6	May 68	11.1	0.6
			May 69	9.9	0.7	May 69	9.9	0.7
May 70	7.6	0.6	May 70	6.4	0.4	May 70	6.9	0.4
May 72	9.0	0.4	May 72	6.9	0.4	May 72	8.3	0.4
Jun 73	5.5	0.4	Jun 73	5.0	0.4	Jun 73	5.3	0.4
Jul 74	3.4	0.3	Jul 74	3.6	0.3	Jul 74	3.2	0.3
Jun 75	6.4	0.5	Jun 75	5.5	0.5	Jun 75	5.9	0.5
Jun 76	8.6	0.5	May 76	7.1	0.4	May 76	8.3	0.4
May 77	9.9	0.4	Aug 77	6.7	0.3	Aug 77	6.7	0.3
May 78	9.9	0.5	May 78	8.5	0.4	May 78	8.7	0.5
Apr 79	10.8	0.4	Apr 79	8.5	0.3	Apr 79	8.7	0.3
Jun 80	7.4	0.6	Jun 80	6.4	0.5	Jun 80	6.7	0.5
Aug 81	5.1	0.6	Aug 81	4.1	0.6	Aug 81	4.4	0.6
May 82	11.3	0.5	May 82	11.3	0.4	May 82	11.3	0.5
Jun 83	7.6	0.6	Jun 83	6.9	0.5	Jun 83	7.1	0.5
Jul 84	3.9	0.4	Jul 84	3.0	0.3	Jul 84	3.2	0.4
Jul 85	6.1	0.4	Jun 85	5.9	0.3	Jul 85	6.4	0.4
Sep 87	4.4	0.4	Sep 87	3.7	0.3	Sep 87	3.7	0.4
Jun 88	6.2	0.6	Jun 88	5.7	0.6	Jun 88	5.7	0.6
Jul 90	6.2	0.3	Jul 90	3.9	0.3	Jul 90	4.2	0.3
May 91	10.4	0.7	May 91	9.0	0.6	May 91	9.2	0.6
Jun 92	8.6	0.6	Jun 92	7.9	0.5	Jun 92	8.1	0.5
Sep 93	5.6	0.4						
Aug 94	16.1	0.8	Aug 94	16.1	0.6	Aug 94	16.1	0.7
Mean	8.4	0.5		7.0	0.4		7.3	0.5

(* Flooding events of less than three months are not included.)

Table 10
Approximate Duration of Drying (Months) and Depth Below Ground Surface (ft) for Each Dry Event During the 1965-1995 Period of Record in the Mid Perrine Marl Marsh Indicator Region 3

NATURAL SYSTEM MODEL			ALTERNATIVE 3			ALTERNATIVE 4		
Start Dates of Dry Events	Months	Max Depth	Start Dates of Dry Events	Months	Max Depth	Start Dates of Dry Events	Months	Max Depth
Jan 65	7.2	3.1	Jan 65	8.1	2.4	Jan 65	8.1	2.5
Feb 66	3.0	1.8	Feb 66	3.5	1.4	Feb 66	3.2	1.5
Mar 67	3.0	2.5	Dec 66	5.4	2.2	Jan 67	5.1	2.4
Mar 68	2.1	1.9	Jan 68	3.5	1.7	Jan 68	3.3	1.6
			Apr 69	1.6	0.5	Apr 69	1.6	0.5
Apr 70	1.4	1.5	Mar 70	2.1	1.6	Mar 70	2.1	1.6
Jan 71	16.4	3.1	Dec 70	17.5	2.8	Dec 70	17.1	2.7
Feb 73	3.7	2.1	Dec 72	4.6	1.8	Feb 73	4.4	1.8
Dec 73	6.4	2.5	Nov 73	7.9	1.9	Nov 74	7.9	2.0
Nov 74	7.4	3.1	Oct 74	7.7	2.5	Oct 74	7.7	2.6
Jan 76	5.1	1.8	Dec 75	5.5	1.4	Dec 75	5.1	1.4
Feb 77	3.0	1.8	Jan 77	6.9	1.5	Jan 77	6.7	1.5
Mar 78	1.4	0.6	Mar 78	2.1	0.7	Mar 78	1.8	0.6
Feb 79	1.8	1.8	Jan 79	2.8	1.9	Jan 79	2.8	1.7
Mar 80	2.8	1.5	Jan 80	5.1	1.7	Jan 80	4.9	1.8
Jan 81	6.7	2.6	Dec 80	7.4	2.1	Jan 81	7.2	2.5
Jan 82	4.4	2.1	Dec 81	5.4	1.5	Dec 81	5.1	1.8
May 83	0.9	1.0	May 83	1.2	1.2	May 83	1.1	1.2
Jan 84	6.2	2.6	Jan 84	6.9	2.1	Jan 84	6.7	2.2
Nov 84	7.5	2.6	Oct 84	7.9	1.9	Nov 84	8.2	2.1
Feb 86	19.1	2.3	Dec 85	20.8	2.0	Jan 86	19.9	2.0
Jan 88	4.2	2.5	Jan 88	4.8	2.0	Jan 88	4.8	2.0
Dec 88	19.7	2.7	Nov 88	20.1	2.0	Nov 88	20.1	2.1
Feb 91	3.2	1.3	Nov 90	5.6	1.2	Dec 90	5.4	1.2
Mar 92	2.3	1.5	Feb 92	3.6	1.6	Feb 92	3.4	1.7
Feb 93	7.1	2.3	Jan 93	18.9	2.0	Feb 93	18.7	2.1
Mar 94	6.5	1.2	--------	-----	----	--------	-----	----
Mean	5.9	2.1		7.2	1.8		7.0	1.8

H. Big Cypress Subregion

In all cases targets were conditions predicted by the Natural System Model (NSM).

Performance Based Comments:
South Florida Maps

Annual Average Hydroperiod Differences relative to the NSM were generally similar to those seen in Alternative 3, with the exception of the line of cells in the gap between the north and south portions of the L-28 and in the vicinity of the L-28 Tieback. In most of these cells, NSM conditions were reached. However, there appeared to be no effect on the drier conditions in the area just west of L-28 and north of Tamiami Trail, which expanded in area between the 1995 and 2050 Base scenarios, and again in the Jetport area and the eastern portion of Loop in Alternative 4, despite the removal of L-28 levee and canal. This is probably associated with removal of pooling at the lower end of WCA-3. The much drier areas located in the westernmost 2-3 columns of the model, and along the northern boundary of the Big Cypress and the northeast corner of the Big Cypress region remain. The 2A-2B decompartmentalization had no significant effect on the Big Cypress Alternative 4 conditions.

Relative to the 2050 Base, Hydroperiod Benefits /Impacts in the Big Cypress from the Starting Point, Alternative 1 or 2 scenarios were located in the southeast corner of the area and were minor and very scattered. Alternatives 3 and 4 overshoots occupied a large portion of this same area, although they were generally of less than 30 days duration. In Alternative 4, there was a small portion of the eastern Loop where conditions were significantly worse compared to the 2050 Base condition. Hydroperiods were improved over a large area from the southern end of the L-28 Interceptor to the northern end of L-28 Tieback most likely associated with the additional amounts of water being brought south into this area by L-28 canal.

Ponding Depth Differences within the Big Cypress, when compared to NSM conditions, were similar between Alternatives 3 and 4. The only change even near the area was 0.5-2.0 ft deeper water along the lower end of the north L-28, which is associated with moving water into the area in the L-28 canal.

Relative to NSM, there are some Frequency Of Peak Stage Differences between Alternatives 3 and 4 that are relevant to the Big Cypress, primarily along its eastern boundary. These include: 1) a small reduction in the area that had been showing a slightly higher frequency of lower water levels along the southeastern boundary below Tamiami Trail; 2) a reduction in the frequency of higher water levels in the lower end of WCA-3A and immediately to the south and southwest across Tamiami Trail; and 3) an increase in water levels in the central portion of Conservation Area 3A in the vicinity of the L-28 gap.

Indicator Regions

For the Big Cypress Indicator Regions, there were no significant changes in hydrology from conditions in Alternative 3. Most differences were non-existent (Indicator Regions 32-35,38-39, 41-42,44-45) or minor in the range of 0.2-0.1 ft (Indicator Regions 31, 36-37, 40). West Slough (Indicator Region 13), which had been up to 0.3 ft higher than NSM in Alternatives 1 and 2 and very close to NSM in Alternative 3, was now as much as 0.2 ft below NSM in Alternative 4. In the Northeast Corner of Big Cypress (Indicator Region 43), Alternative 4 water levels were up to 0.3 ft

higher than Alternative 3 and closer to NSM, but only at times when the water table was 2.5-4.5 ft below ground.

In comparing Alternative 4 with NSM, the subteam still sees the same pattern reported for Alternative 3 with indicator regions in the central (32, 33) and southwestern (44) portions of the area showing no real differences; those in the southern (40) and northwestern (41) portions showing minor differences of 5-7% reductions in hydroperiods and up to 0.3 ft lower water levels. The more severe reductions in hydroperiods (33-47%) and water levels (up to 2.0 ft) seen along the west boundary (Indicator Regions 34, 35) are still present and are still likely to be more a result of model problems than real world problems. In addition, indicator regions in the northeast (42) and northeast corner (43) of the Big Cypress still have severe biologically significant reductions in hydroperiods (19 and 70%, respectively) and water levels (up to 0.5 and 2.5 ft, respectively). Indicator regions in the area along the eastern boundary of the Big Cypress from Mullet Slough south to Tamiami Trail (31, 36-39, 45) still have minor to moderately severe, biologically significant reductions in hydroperiod (3-13%) and water levels (up to 0.2-0.5 ft). The West Slough Indicator Region (13) has shown the most dramatic changes in recent Alternatives. Prior to Alternative 3 hydroperiods were 8% higher than NSM and water levels were up to 0.3 ft higher. In Alternative 3, the hydrology was essentially comparable to NSM, while in Alternative 4, hydroperiods are 5% less than NSM and water levels are up to 0.2 ft lower than NSM.

Big Cypress National Preserve

As predicted by all of the previous base and alternative scenarios, hydroperiods in less than half of the North Big Cypress matched NSM conditions. Most of these acres had 30-90 day shorter hydroperiods, but for about 10% of the acres, hydroperiods were 90-180 days shorter. There were no differences among any of the scenarios, except Alternative 4, which resulted in an approximate 3% improvement in conditions. This improvement is associated with increased water in lower Mullet Slough that is being brought into the area by the L-28 canal.

In the South Big Cypress there are small differences among the scenarios, but only about 10-15% of the area is different from NSM, and most of those deviations are only 30-90 days longer or shorter. The 30-90 day longer-than-NSM hydroperiods that appeared to be associated with the adjacent Everglades in earlier scenarios were eliminated in Alternative 3, while the shorter-than-NSM hydroperiods that appeared to be associated with the are a southwest of the north end of L-28 had not changed. In Alternative 4, the area with 30-90 day shorter-than-NSM hydroperiods had increased by about 5%, primarily in the area to the west of L-28 and in the eastern portion of the Loop.

Average overland flows to the Gulf of Mexico in the Big Cypress still show substantial spatial variability, although within the western and eastern Big Cypress cross sections, flows predicted by the various base and alternative scenarios were similar to one another but different from NSM. In western Big Cypress National Preserve, dry season flows were similar among all scenarios, except NSM which had about 50% more flow than the other scenarios during the wet season. In eastern Big Cypress National Preserve,

both wet and dry season flows were about 50% higher in the NSM than all other scenarios.

In the Lostman's area, next to the Everglades, flows were substantially higher among all base and pre-Alternative 4 scenarios during both wet and dry seasons than for NSM. There is also more scenario-to-scenario variability in the Lostman's area than for either of the other Big Cypress flow cross sections, because of the greater amount of hydrologic manipulation in the Everglades than in the Big Cypress. Alternative 3 showed substantial improvement over Alternative 2 in returning both wet and dry flows to a condition more comparable to that seen in the NSM scenario. This was particularly evident in the period from January through August. Alternative 4 has produced substantially lower than NSM flows throughout the year.

In general, given where component changes have been made in the South Florida ecosystem and that the Big Cypress is very much a separate watershed from the Everglades, it is not surprising that the structural and operational changes made in all of the alternatives have primarily affected lands only in the eastern portion of the Big Cypress along its boundary with the Everglades. It was interesting that removal of the L-28 had so little effect on the hydrology of the eastern Big Cypress in the area near where this structure is located, and it was even more interesting that it became drier instead of wetter.

Performance Measures and Indicators Used:

1. Hydroperiod Distribution Maps
2. Hydroperiod Improvement Maps
3. Hydroperiod Differences Maps
4. Ponding Depth Maps
5. Ponding Depth Differences Maps
6. Peak Stage Differences Maps (NSM)
7. Indicator Regions in or near Big Cypress (13, 31-45)
    - Weekly Stage Hydrographs
    - Weekly Stage Duration Curves
    - Temporal Variation of Stage
8. Big Cypress National Preserve
    - North and South Big Cypress National Preserve
        - NSM and 50B hydroperiod matches
    - Average wet/dry season flows toward Gulf of Mexico
        - western Big Cypress National Preserve
        - eastern Big Cypress National Preserve
        - Lostman's
    - Average monthly overland flows toward Gulf of Mexico
        - western Big Cypress National Preserve
        - eastern Big Cypress National Preserve
        - Lostman's

Problem Identification:

The Annual Average Hydroperiod Difference maps have consistently shown drier than NSM conditions in a large area in the northeast corner of the Big Cypress. The most significant problem area, with 90 to 365 days shorter hydroperiods and a water table that is consistently 1-2.5 ft below NSM year round levels (Indicator Region 43, Normalized Weekly Stage Duration Curve and Temporal Variation in Mean Weekly Stage), is bounded by the L-28 Interceptor and the north end of L-28. A significant but smaller problem area, with 90 to 180 days shorter hydroperiods, occurs at the west end of the Western Feeder Canal. However, this area lies along the model boundary, where models tend to be less accurate. The problem continues with less severity (30-90 days shorter hydroperiods and 0.2-0.5 ft below NSM year round water levels) to the west of the L-28 Interceptor, and south and west of the Western Feeder Canal that flows into the L-28 Interceptor. We were interested in trying to understand where these problems were real, as opposed to possibly being associated with problems with the model, such as boundary influences or inadequate information upon which to base an accurate model of the area.

Examination of maps and aerial photos, discussions with knowledgeable individuals, and an aerial reconnaissance were conducted on February 23-25 to assess current conditions in this area. Much of the land bounded by the L-28 Interceptor and the north end of the L-28 and land north of the Western Feeder Canal has been drained and put into various types of agricultural production. From the air the lands west of the L-28 Interceptor and south of the Western Feeder Canal were not visibly altered hydrologically, despite the presence of numerous stands of melaleuca. The area in WCA-3A at the outlet of the L-28 Interceptor appeared to be affected by increased duration of inundation and increased nutrients. Cattails were abundant in this area, which would suggest the increased nutrient loads. Willows were also abundant, which would suggest the area was probably too wet for too long to burn as often as it had before construction of the L-28 Interceptor.

None of the bases or alternatives has significantly influenced hydrologic conditions in the northeast corner of the Big Cypress. Alternative 4 did increase hydroperiods in the cells that overlap the north L-28 canal, but these changes are probably more a reflection of changes on the east side of the L-28 than in the area we are evaluating to the west.

The goal / target is to restore NSM conditions.

Recommendations:

As a result of the above observations, a number of recommendations were agreed upon by the L-28 Interceptor Design Team to evaluate the effects of the existing structures on the hydrology of this region. It is hoped that by testing changes in these components, we would be better able to sort out influences of actual hydrologic alterations in the area from influences resulting from problems with the model. In addition, it is very important that we thoroughly evaluate effects of changes that might occur in nutrient distribution patterns before any decisions are made in redesigning the plumbing of this area.

1. Degrade the levee on the west side of the L-28 Interceptor and fill the canal to restore overland flows to adjacent wetlands and to reduce the point source of flows and nutrients at the end of the canal. The Miccosukee representative suggested this would help them meet their water quality targets for water entering the reservation in this canal. The levee on the east side of the canal would remain to protect the developed lands to the east. Since the area where the overland flow would now go appears to be reasonably healthy, there are concerns about these additional inputs both in terms of water quantity and quality, which the modeled scenario could help evaluate. Another concern was uncertainty about the importance of flows coming down the L-28 Interceptor in meeting hydrologic objectives in the central portion of the WCA-3A.

2. The S-190 culvert structure would have to be replaced with a pump station to maintain the current level of drainage of the upstream developed area, when the downstream canal was filled.

3. Allow water in the Western Feeder Canal to flow south. Various suggestions from the Seminole representative and National Park Service staff suggested the possibility of breaching the levee along the south side of the canal or siphons that could carry water over the levee. Again, since the area south of the canal appears to be reasonably healthy, there are some concerns about these additional inputs both in terms of water quantity and quality, which the modeled scenario could help evaluate.

4. There should be an evaluation of the need for a WPA or STA that could treat water from the Western Feeder Canal and L-28 Interceptor Canal before it is sent south and west, respectively, into relatively undisturbed areas, since nutrient loads in these waters appear to be increasing over time as the upstream watershed has developed.

5. There was concern about improving drainage of the land between the north L-28 and L-28 Interceptor. All water currently leaving the north L-8 is pumped out by the S-140 structure, since this canal dead-ends at the L-28 Interceptor Levee. This creates a situation where a certain amount of the water being pumped by the S-140 moves south in WCA-3A, and because of the hydrologic gradient between a higher 3A and a lower L-28 Canal, seeps back into the L-28 Canal, where it moves north and has to again be pumped out by S-140. A more efficient system would be to install a weir on L-28 south of S-140 and a new pump station further south on L-28. In Alternative 4, water is entering WCA-3A from an 8-mile-long spreader canal at the bottom end of L-28 north canal. If this latter design is maintained, this recommendation would adequately addressed.

Problem Identification:

In the area south and southwest of the junction of Tamiami Trail and L-28, there are mixed signals as to whether the area is getting wetter or drier depending on the performance measure used.

Annual Average Hydroperiod Differences from NSM suggest that there was no change between Alternatives 3 and 4, while Hydroperiod Benefits / Impacts suggest that the area is getting wetter. This discrepancy could be a result of there being a hydroperiod difference between Alternatives 3 and 4 of more than 0 days for the Hydroperiod Benefits / Impacts Performance Measure but less than 30 days for the Annual Average Hydroperiod Differences Performance Measure.

Frequency of Peak Stage Differences suggest that the area showing a slightly higher frequency of lower water levels is decreasing from Alternatives 3 to 4. Therefore, this area is getting wetter.

The West Slough Indicator Region 13 suggests that this area has steadily gotten drier from Alternative 2 through Alternative 4. The Lostman's flow cross section also has shown a steady progression among the Alternatives from higher to lower than NSM conditions in Alternative 4.

Thus, the regional map performance measures suggest wetter conditions and the indicator region and flow cross-section suggest drier conditions in the same general area. It may be that these discrepancies are small enough that they are just within the uncertainty of the models, and there might not be a real discrepancy in this area.

Recommendation:

1. Evaluate whether these discrepancies between the performance measures are real or are more likely just a function of inherent uncertainty within the model.

I. Water Quality

Performance Based Comments:

For Lake Okeechobee, Alternative 4 was approximately equivalent to Alternatives 2 and 3 for all performance measures except wet season phosphorus out-loads continued to decline (outflows from the lake). This indicates a favorable trend for the lake and downstream waters/wetlands. The decline in outloads observed in Alternative 4 is assumed to be a result of the operational changes included in Alternative 4 for directing water from the lake to the aquifer storage and recovery (ASR) wells and recovering water from the ASR wells. The team continues to note that a reversal of lake eutrophication is not expected to be observed during the 23-year simulation period for the model (1973-1995). This is due primarily to the existing in-lake nutrient loads and nutrient cycling processes. In-lake nutrient loads are not expected to diminish significantly during the model simulation period. However, the team is attempting to evaluate whether a trend indicating long-term reversal of lake eutrophication can be detected by running the Lake Okeechobee Water Quality Model for a longer period, and making additional assumptions about phosphorus in-load (in-flows to the lake) reductions which may be expected to occur between now and 2050.

Phosphorus concentrations and loads within the Everglades Protection Area (EPA) as simulated by the Everglades Water Quality Model (EWQM) for Alternative 4 have not yet been evaluated by the team (EWQM not yet run for Alternative 4). However, Dr. William Walker completed a draft evaluation of Alternatives 2, 3, and 4 under contract to Everglades National Park. Dr. Walker's work looks at the effect of an alternative plan, including the proposed design and operation of the EAA Reservoir (Component G) on the operation of the Everglades Construction Project (ECP) and the downstream Water Conservation Areas (WCAs). Members of the Water Quality Team reviewed Dr. Walker's work subsequent to the Water Quality Team meeting on March 3, 1998. Presently, Dr. Walker requests that no opinions be formed based on his preliminary work. However, for purposes of completing a preliminary evaluation of Alternative 4, the team submits the following observations:

In terms of phosphorus load reductions in the stormwater treatment areas (STAs) which are included in the Everglades Construction Project, Dr. Walker's work indicates that phosphorus load reductions in STA 1W increased approximately 20% in Alternative 4 as compared to Alternative 3 (presumed to be a result of the volume reduction modeled in Alternative 4 as compared to Alternative 3). Surprisingly, load reduction was also increased 10% in STA 1W in Alternative 4 compared to Alternative 2. However, load reduction decreased approximately 9% in STA 2. All other STA load reductions were approximately equivalent for all of the alternatives evaluated. Phosphorus load reduction in the EAA reservoir is equivalent for Alternatives 3 and 4, but increased approximately 12% compared to Alternative 2. An increase in phosphorus load reduction is assumed to be beneficial to the operation of the STAs and downstream receiving waters. A decrease in load reduction may create an adverse impact on the operation of the STA; however, the thresholds at which a decrease in load reduction would cause an STA to fail to meet the interim and final phosphorus concentration targets have not yet been determined.

In terms of meeting the interim phosphorus concentration, load reduction, and 28% increased flows to the EPA targets in the Settlement Agreement and the Everglades Forever Act, Alternative 4 performed as follows: Alternative 4 achieved the interim phosphorus concentration target (50 ppb) for both Loxahatchee National Wildlife Refuge (LNWR) and the Water Conservation Areas; Alternative 3 did not achieve the target for LNWR (over approximately 10%). Percentage of phosphorus load reductions to LNWR in Alternative 4 (83% load reduction) was also improved compared to Alternative 3 (72%). The target percentage load reduction to LNWR is 85%; however Alternative 4 was equivalent to Alternative 3 for load reductions to the WCAs (67% load reduction). Both alternatives fell short of the target (80% load reduction). Alternative 4 delivered an 18% increase in flows to the WCAs, which was greater than Alternative 3 (17% increase) or Alternative 2 (11%), but is still significantly short of the 2050 Base condition (26% increase).

Average inflow water loads to STA 1E in Alternative 4 are approximately equivalent to the 1995 Base (this is the condition for which the ECP was designed). Water loads to STA 1W in Alternative 4 are increased approximately 17%. Water loads to STA 2 are increased approximately 44%. Water loads to STA 3+4 are increased approximately 18%. Water loads to STA 5 are increased approximately 45%. Water loads to STA 6 are increased approximately 5%. For the ECP as a whole, water loads increased approximately 32%. An increase in water load may impair the function of the STAs as designed, and may result in increases in outflow phosphorus concentration above the interim (50 ppb) and default (10 ppb) numeric targets in the Everglades Forever Act. The increase in water loads results from: a) using the 1965-1995 hydrologic period of record, which was wetter than the 1979-1988 period of record from which the ECP was designed; and b) a change in operational rules for Lake Okeechobee and the WCAs to achieve hydrologic objectives.

Performance Measures Used:

The team used performance measures and indicators developed for the South Florida Water Management Model, Everglades Water Quality Model, and the Lake Okeechobee Water Quality Model. Additionally, the team prepared a summary table for this alternative showing the size of the plan components and the source of water delivered to each plan component, receiving water bodies for each component, classification and special status, ambient phosphorus concentrations (if known), and phosphorus treatment efficiency, as well as observations about the hydrologic characteristics of the components. A copy of the table appears at the end of this report.

South Florida Water Management Model

1. Stage Duration Curves and Stage Hydrographs for all of the reservoirs included in this alternative plan (North Reservoir, Taylor Creek/Nubbins Slough Reservoir, St. Lucie Reservoir, Caloosahatchee Reservoir, EAA Reservoir, Site 1 Reservoir, C-11 Reservoir, C-9 Reservoir, Central Lakebelt Reservoir, North Lakebelt Reservoir, Bird Drive Reservoir).
2. Water budget data from FTP site.

Everglades Water Quality Model
Not yet evaluated for Alternative 4.

1. Mean grid cell water column phosphorus concentrations within the Everglades Protection Area (EPA).
2. 14-station (per Settlement Agreement) mean phosphorus concentration within Loxahatchee National Wildlife Refuge.
3. Mean annual phosphorus load to the EPA.
4. Mean basin phosphorus concentration.
5. Combined flow-weighted mean phosphorus concentration at S12s/S333 (per Settlement Agreement).

Lake Okeechobee Water Quality Model

1. Lake Okeechobee volume.
2. Cumulative phosphorus loading into Lake Okeechobee.
3. Cumulative phosphorus load in discharges from Lake Okeechobee.
4. Phosphorus flux to sediments.
5. Difference from Future Base concentrations for total phosphorus, chlorophyll-a, and blue-green algae.
6. Box plot comparisons of total phosphorus, chlorophyll-a, and blue-green algae.

W. W. Walker's STA & Reservoir Performance Measures

1. Percentage Phosphorus Load Reductions.
2. Phosphorus Concentrations for Combined Inflows to LNWR & WCAs.
3. Percentage Volume Increase to WCAs.
4. Flow-weighted Mean Outflow Phosphorus Concentrations.
5. Average Water Loads.

Recommendations:

1. The storage reservoirs should be operated to optimally capture phosphorus contained in inflows and remove phosphorus from outflows. To the extent that phosphorus is a surrogate for other pollutants, optimal operation of these facilities for phosphorus removal will contribute to additional downstream pollution load reductions. The team's present recommendation for optimal operation is to maintain at least 2.5-ft depth in the reservoirs, with a minimum hydraulic retention (residence) time of 21 days prior to discharge upon re-wetting (when depths fall below 2.5 ft). Walker's evaluation of the EAA reservoir indicates that in Alternative 4, approximately 95% of the total outflow volume from the EAA reservoir had a residence time exceeding 21 days. Preferably, 100% of the total outflow volume should meet the recommended 21-day minimum residence time.
2. An ad hoc Restudy issue team should be created to evaluate the projected increase in average water loads to the ECP, and make further recommendations regarding the effect of the projected increase on STA design and operation. In particular, the implications of the increased volume on the Phase 2 treatment requirement should be evaluated. The STA Design Group, Everglades Technical Advisory Committee, or

technical staff in support of the Technical Oversight Committee established by the Settlement Agreement could facilitate this evaluation.

3. The modeling team should develop the previously requested performance indicator summarizing average annual structural flows to the Everglades Protection Area from all sources, not just the Everglades Construction Project. The Water Quality Team views this as a particularly important indicator of potential water quality impacts associated with each alternative plan; such a performance indicator would also clarify potential land use conflicts and treatment costs.

Subteam Issues:

Restudy components must meet State and Tribal water quality standards, as appropriate. In particular, increased flows to the Everglades Protection Area (over that which is in the 2050 Base condition, i.e. Everglades Forever Act fully implemented) must meet the yet-to-be-established numeric phosphorus criteria for the EPA (default concentration = 10 parts per billion). The technology (and hydrologic demands, if any) required to achieve this standard has not yet been determined. Furthermore, it can be reasonably assumed that the technology (and concurrent land and hydrologic demands) will vary for Restudy components, depending upon location. Component design should continue to take into account current and future land uses in the vicinity of the components and the estimated land acquisition, construction, and operations costs to assure that water quality treatment facilities necessary to meet water quality standards are included in the final design.

Additionally, treatment costs may not be limited to just those necessary to achieve surface water standards. Restudy components capable of polluting ground water (ASR, discharges in the vicinity of underground drinking water sources) must include treatment necessary to achieve ground water quality standards prior to introduction of discharges into the ground water.

The team does not expect to observe a recovery of Lake Okeechobee during the simulation period for the model(s). Therefore, the long-term benefits of treatment facilities and wetlands restoration in the lake watershed are not readily observable in the water quality performance indicators which are available to evaluate the affect of the Restudy on the lake. Although modeling results may lead the Restudy Team to empirically conclude that there are no water quality benefits achieved by including water quality treatment features in the Restudy components when compared to 2050 Base conditions, the Water Quality Team intuitively concludes that such projects and facilities will have long-term water quality benefits beyond the planning horizon for the Restudy.

Although the team concurs with the method for determining mean phosphorus concentration values in the Taylor Creek/Nubbins Slough basin (528 ppb), additional information is needed about the design and operation of the STA proposed for that basin. While it is understood that more detailed information about the design and operation of this component would occur in future detailed design work if this component is included in the final comprehensive plan, it is noted that the STA is assumed to achieve an 80%

reduction in basin loads and concentrations prior to discharge to Lake Okeechobee (this efficiency is at the upper end of the range of phosphorus reduction efficiency for STAs).

Furthermore, the team has not determined that 107 ppb is the correct target concentration for discharges to Lake Okeechobee (this concentration will not necessarily contribute to a reduction of ambient lake water column phosphorus concentrations below the current mean concentration of approximately 100 ppb). Additional treatment works may be necessary to achieve target concentrations.

Components K4, X3, and Y3 involve increasing the amount of water contained within the West Palm Beach Water Catchment Area. This involves collecting runoff from the L-8, C-51, and C-17 watersheds (Class III waters), and directing it via the M-Canal and C-18 Canal to the Catchment Area. The C-18 Canal, M-Canal, and the Catchment Area are all Class I waters (Potable Water Supply). To receive water quality certification under the Clean Water Act, Restudy components which create new surface waters discharges into Class I waters would have to discharge water of sufficient quality to assure that the Class I use classification is maintained. To further evaluate future treatment requirements, if any, ambient pollutant loads and concentrations within the watersheds would have to be quantified and compared against minimum, general, and Class I surface waters criteria contained within Florida Administrative Code Rule 62-302.

Components D2 and GG3 involve storing Lake Okeechobee and Caloosahatchee River watershed runoff in 122 10 MGD aquifer storage and recovery wells, creating a total of 1,220 MGD of surface water to be injected and stored in the Floridan aquifer. These components create significant hydrologic benefits, especially in the lake. However, there are some troubling assumptions about Lake Okeechobee and Caloosahatchee ASR as presently modeled. Particularly, the technical feasibility of injecting and a 70% recovery of 1,220 MGD has not yet been proven, nor has ASR on this scale been implemented anywhere that the team is aware of. Second, no treatment is assumed to be necessary prior to injection. This assumption is not consistent with current regulations for injection of water into potential underground sources of drinking water. At a minimum, the cost for at-the-wellhead treatment should be estimated and added to the cost of the ASR component for Lake Okeechobee to more conservatively calculate the potential cost of this component. Third, the water quality and ecological impacts of recovering water stored in the aquifer and discharging it directly to the Lake Okeechobee and Caloosahatchee basin waters have not been reasonably evaluated. The team has been made aware that the potential impacts include increased production of methyl mercury, changes in pH and temperature, and the introduction of water containing low-to-no dissolved oxygen. Water which is recovered from ASR wells may require additional treatment (e.g., wetlands) prior to discharging to Class I (Lake Okeechobee) and Class III (Caloosahatchee basin) surface waters to maintain the use classifications and ecological integrity of those waters and downstream receiving waters. Further detailed evaluation of ASR water quality and its impact on surface waters is necessary. An ad hoc ASR Team is being created for such a purpose. However, since it may not be possible to complete such an evaluation given the schedule for drafting a feasibility report and a PEIS for the Restudy, the Restudy Team should consider including additional treatment facilities and

costs in the comprehensive plan to achieve and maintain water quality and ecological targets in Lake Okeechobee and Caloosahatchee basin waters potentially affected by ASR water.

According to the SFWMM water budget data files, approximately 80 k ac-ft from the Northern L-8 Basin is discharged to Lake Okeechobee. Phosphorus concentrations at certain locations within the Northern L-8 Basin are known to be high (approximately 226 ppb). The 2050 Base condition for the Restudy does not include treatment of Northern L-8 Basin flows prior to discharge to the lake (2050 Base includes construction/operation of the ECP, which includes the yet-to-be constructed S-309 pump station delivering L-8 flows to the lake). Northern L-8 Basin flows need to be evaluated in terms of contribution to net Lake Okeechobee phosphorus in-loads. If warranted based on an evaluation of ecological impact, a treatment facility should be included in Restudy alternatives to reduce phosphorus loads from the L-8 Basin, similar to that which was designed for Component A4 (North Storage Reservoir/STA). .

ALTERNATIVE 4 COMPONENTS WQ ANAYSIS

Component	Source Water	Class OFW	[P] ppb	Receiving Water	Class OFW	[P] ppb	Storage Volume	Treatment Efficiency/ Regulatory Reqments	No Hydr Perfor
A4 North Res.	Lake O. Kiss. WS (?)	I III N	?	Lake O.	I N		200,000 af	?	Dry 60 time; (dry 75 time)
B2 St. Lucie Res.	Lake O. St.L WS	I/III N	100 ?	St. Lucie River	III N		40,000 af	?	Below 90% o dry 50 time; A stages faster f max de
C1 St. Lucie Est. Deliveries	Lake O. St. L. Res.	I/III N	100 ?	St. Lucie Estuary	II/III Y			0 (Lake O.) ? (res.)	
D3 Caloos. Res.	Lake O./ Caloos. WS	I/III N	100 ?	C. River	I/III Y		160,000 af	C. Riv. In Lee Co. is Class I	Below 50% o dry 30 time.
D3 Caloos. ASR	Lake O. Caloos. WS	I/III N	100 ?	C. River (estuary)	I/III		220 MGD = 246,400 af	0 any treatment prior to ASR?	UIC re apply t ASR. year capabi
E1 Caloos. Est. Deliveries	Lake O. Caloos. Res.	I/III N	100 ?	Caloos. Estuary	III/II Y			0 (Lake O.) ? (res.)	Alt 3 deliver close t target.
F3 Lake O. Reg Schedule	Lake O.	I	100	St. L & Caloos. Rivers, EAA, WCAs.	I/III			0	No add Benefi assum from F Schedu
G3 EAA Reservoirs	Lake O EAA runoff	I/III/IV(?) N	100 120	WCA 3 (via STA 3/4)	III/IV N	10	1 @ 20,000 af 1 @ 40,000 af 360,000 af	?	EAA = 70% o Glades ft. 95% time.

H4 E'glades Rain-driven Operations	ECP/ STAs	III N	10	WCAs	III Y	10		N/A	Flows ENP uncont check budget ECP.
I3 Not included in Alt. 4									WCA- decom mental

Component	Error! Bookmark not defined. **Source Water**	**Class OFW**	**[P] ppb**	Error! Bookmark not defined.**Receiving Water**	**Class OFW**	**[P] ppb**	**Storage Volume**	**Treatment Efficiency/ Regulatory Reqments**	Er Book n define sEr Book not de **Hydr Perfor**
J									Not in
K4 L-8 Project	L-8 Basin, C-51 Basin, C-17 Basin	III N	?	M Canal, WPB CA Lox. Slough	I Y		25 MGD ASR= 28,000 af	?	STA includ what a treatm require ?
X4 C-17 B'pumping	C-17 WS	III N	?	M Canal, WPB CA (via STA)	I		STA = 1,800 af (Alt 3 = 2,200 af)	?	No hydrol specs STA; must a Class wqs
Y4 C-51 B'pumping	C-51W WS	III N	?	WPB CA	I		STA = 2,000 af (Alt 3 = 2,400 af)	?	No hydrol specs STA; must a Class
L3 Coastal Wellfields	GW							N/A	Operat change includ Rivier Dania, Miram Browa 3A. G regs. a
M4 Site 1 Res.	Hills. Canal	III N	?	Hills. Canal WCA-2A	III N	? 10	9,960 af	WCA-2A = 10 ppb	How m discha WCA- Res. b ft. 55%

									time.
M4 Site 1 ASR	Hills. Canal +	III N	?	Hills. Canal	III N	?	75 MGD ASR to improve efficiency ; = 84,000 af (Alt 3 = 25 MGD ASR)	Injected water must meet primary drinking water stds.	100 % recove assum
N2 WCA-2B Levee Seepage Management	WCA- 2B								Not in in Alt.
04 WCA-3A/B Levee Seepage Management	WCA- 3A/B	III N	10	Indirect to ENP via Lake Belt SA.	III Y	10			Buffer seepag WCA seepag Buffer U.S 27 WCA- seepag to Lak SA; nc via S-9

Component	Source Water	Class OFW	[P] ppb	Receiving Water	Class OFW	[P] ppb	Storage Volume	Treatment Efficiency/ Regulatory Reqments	N Hydr Perfo
P2 NNR Div. Canal & C-11 Treatment Fac.	NNR WCA-2B								Not inclu Alt 4.
Q4 WC-11 Diversion Canal & Reservoir/ STA	WC-11 WS	III N	?	North Lakebelt Res.	III N	?	1,600 ac. Res/ STA.	N/A	Reser TA b 2.0 ft of tim dry20 time.
R4 C-9 Reservoir/ STA	NLBS AC-9, C-11 WS	III N	?	C-9, C-6, C-7, C-2, C-4	III N	?	10,000 af	B'pumping to WCA-3A?	Res. c nearly of tim opera confli with S desig princi provi recha functi only.
S4 Central Lakebelt Res.	WCA-3B	III N	?	L30/NESRD-B Lev. Canal S.Creek Canal C-6, C-9	III N Y(ENP)	? 11	5,200 ac. reservoir; +11 to -15 (26 ft. differential). Up to 135,200 af	Polishing marsh (?) Impacts on NW Wellfield (?). Limestone filter (?)	Res. l groun 90% c time.
T1 C-4 Structure	C-4	III N	N/A	C-4	III N		N/A	N/A	WCA Seepa contr
U4 Bird Drive Recharge Area	WC-4 WS L-31N	III Y(L-31N)	? 10	C-4 Seepage to L-31N via S-356s	III N Y(ENP)	? 10	11,508 af Need to know what componen t is of	Seepage of adequate wq?	Belov 100% time; 5.5 8 time.

							lower wq		
FF3 S-356 A&B	L-31N & Bird Dr. Res. seepage	III N	?	ENP	III Y	11	N/A	Direct discharge to ENP; (NESRS) treatment adequate/necessary? Increased P load?	Two pump

Component	Source Error! Bookmark not defined. Water	Class OFW	[P] ppb	Receiving Water	Class OFW	[P] ppb	Storage Volume	Treatment Efficiency/ Regulatory Reqments	Er Book n define sEr Book not de Hydr Perfor
V2 L-31N Levee Seepage Mgt.	ENP	III Y	10	ENP	III Y	10	N/A (b'pump wet season seepage)	N/A	
W2 T. Creek/ N. Slough Res/STA	T.Creek N. Slough WS	III N	528	Lake O	I N	100	50,000 af	528 - 107 ppb. Is this reasonable based on size, conc., & load?	100% runoff than 5 af trea STA. dry 70 time (S dry? = source
AA3 Add'l S-345s	WCA 3A	III N	10						Not in in Alt.

BB4 D-B Levee/ Pennsuco Seepage Control		III N	?	NW Wellfield	III (recharge canal) GW/DW	?	N/A	Treatment requirements to add incr. surface water to wellfield recharge canal?	Lakebe STA adequa treat to GW/D stds?
CC3 Broward Co. Canals	Basin runoff	III N	?	Canals, wellfields	III GW/DW	?	Quantify increased amount?	N/A	Increas canal s recharg wellfie
DD3 Holey Land Rainfall Operations	Lake O, Runoff, Roten-berger via STA 5/6	I III N Y	100 10	Holey Land WCA-3A via HPR features of ECP	III N	10		Lake O. deliveries treated via STAs?	Need t know l much r Lake C water i to ECF provid Rainfa deliver
EE3 Rotenberger Rainfall Operations	STA 5	III N	10	Roten-berger; Holey Land	III Y	10		Dry-out implications for STA?	Increas volum deliver STA 5 capaci there?
GG4 Lake O ASR; same as Alt 3 except for operation Schedule.	Lake O	I N	100	Lake O	I N	DW	1,000 MGD 1,120,000 af	Fecal coliforms? Treatment required? Costs can be estimated?	More v availab lake du dry tim
HH3 S-343A & B Operational Change									Not in in Alt.

Component	Source Water	Class OFW	[P] ppb	Receiving Error! Bookmark not defined. Water	Class OFW	[P] ppb	Storage Volume	Treatment Efficiency/ Regulatory Reqments	Notes Book not de Hydr Perfor
II3 G-404 Modificatio n	STA 3/4	III N	10	WCA 3A	III N	10	N/A	Increased pumping to achieve HPR Goals.	Any di impact STA?
JJ3 LNWR Rainfall Schedule									Not in in Alt.
KK4 LNWR Internal Canal Structures	LNWR	III Y	10	LNWR WCA 2A	III Y N	10	N/A	N/A	Structu added achiev hydrol targets wq im Compa hydrol perfor to Alt.
LL4 C-51 ASR	C-51 WS	III N	? coli - for ms?	C-51	III N	DW	270 MGD 302,400 af	Treatment required? to be injected into Biscayne; into Floridan	70 % recove assume water t injecte surface 51) wa
MM4 Hillsboro Canal ASR	Hills- boro Canal	III N	? coli for ms?	Hillsboro Canal	III N	DW	185 MGD 207,200 af	Treatment required?	70 % recove assume water t injecte surface (Hills. water
NN3 North New River ASR									Not in in Alt.
OO4	C-111	III	?	ENP via	III	10	N/A		C-111

Phase II of Exp. Program	Basin, L-31W	N		S-332D into L-31W	Y (ENP)				Projec as Alt except pumps potenti proble assoc. increas dry-sea flows f C-111 to ENP
PP3 C-7 Basin B'pumping	C-7 Basin								Not in in Alt.

Component	Source Water	Class Error ! Bookmark not defined. OFW	[P] ppb	Receiving Water	Class OFW	[P] ppb	Storage Volume	Treatment Efficiency/ Regulatory Reqments	Er Book n define sEr Book not de Hydr Perfor
QQ4 Decompart. WCA-3								WQ impacts associated with decomp? Redistributi on of water column P.	Remov structu barrier betwee WCA (incl. I & 3B a ENP
RR4 Hydro-pattern impr. in WCA-3A (relocate S-140; incr. capacity)	L-28/L-28I	III	?	Central WCA-3A	III	10		Pumped redistributi on of water column P.	WQ depend upon S Tribe v project Non-E structu
SS4 Relocate Dade Co. Water Supply Deliveries									Miami elimin No adv wq imp assume
TT4 Decompart. WCA-2									Not in in Alt.
UU4 C-23/24 Reservoir	C-23/24, NF & SF WS.			St. L estuary			165,000 af	Nutrient fluxes?	Need h perfor data.
VV4 Central PB Co. Reservoir	LWDD back-pumping			LWDD dist. system			9,960 af	Some wq benefits assumed?	Need h perfor data.
WW4 C-111N	C-111 &	III	?	C-111N, triangle in	III N	?	Size of STA?	STA to be constr. in	Purpos improv

Spreader Canal	C-111E			Model Lands				triangle.	hydrop in S. Dade/M Lands
XX4 N. Lakebelt Storage Area	C-6, C-11, C-9 WS	III	?	C-9 STA, C-9, C-6, C-7, C-4, C-2			3,500 ac; +5.0 ft. to -15.0 ft = 20 ft. differential ; 70,000 af		Zero transm ty assu any po impact NW Wellfi
YY4 WCA-2B flow diversion structures	WCA-2B	III	10	NESRS C. Lakebelt Sn. Creek D-B Levee	III	11 ? ? ?		WCA'2B water should not cause downstrea m impacts	(3) 80(structu from V 2B
Total Available Storage, Alt 4							**3,083,428 af (incl. 1,775 MGD ASR)**		Alt 2 = 988,60 Alt 3 = 2,993,8

1 ac. ft. = 325,851 gallons; 1 MGD = 3.07 ac. ft.; 1 MGD annual volume = 1,120 ac. ft.

LEGEND:

WS = Watershed
ASR = Aquifer Storage & Recovery
ECP = Everglades Construction Project
STA = Stormwater Treatment Area
WPB CA = West Palm Beach Catchment Area
D-B = Dade-Broward Levee
Y = Yes
N = No
W = West
WCA = Water Conservation Area
CSSS = Cape Sable Seaside Sparrow
af = acre feet

J. ATLSS / Threatened and Endangered / Keystone Species

Performance Based Comments:

An individual-based ATLSS simulation and Population Viability Analysis are now available for the western sub-population of the Cape Sable seaside sparrow. Breeding Potential Indices (BPIs) are addressed for other Cape Sable seaside sparrow sub-populations and white-tailed deer. For wading birds, ATLSS outputs for Alternative 4 include a Foraging Conditions Index with separate analyses for "short-legged" and "long-legged" species. Outputs on total fish abundance and fish prey base for wading birds are also available. Differences in input data make quantitative comparisons of Alternative 2, Alternative 3 and Alternative 4 outputs to Alternative 1 outputs and/or 1995 Base outputs impossible and makes qualitative comparisons questionable. Performance indicators for Cape Sable seaside sparrows and American crocodiles are also addressed.

Performance:

Fish

The ATLSS fish model predicts that, due to overall wetter conditions in WCA-3B, WCA-2A, west-central WCA-3A and south of Tamiami Trail, Alternative 4 hydrologic conditions will produce average fish abundances consistently higher than those expected for 2050 Base, particularly in Shark River Slough and WCA-3B. This is also true when only prey-sized fish at appropriate wading bird foraging depths are counted. Exceptions occur in WCA-2B, eastern WCA-3A, East Slough and South Big Cypress, where Alternative 4 produces slightly lower fish densities than the 2050 Base. Alternative 4 results are very similar to Alternative 2 and Alternative 3.

Wading Birds

Eastern rookeries (WCA-3A, WCA-3B and NE Shark River Slough) - On average, Alternative 4 predicts slightly lower foraging condition values than 2050 Base for short-legged wading birds and equal to slightly higher values for long-legged wading birds in WCA-3A and NE Shark River Slough. Alternative 4 foraging values are consistently lower in WCA-3B for all wading birds due to deeper water.

Historic Shark Slough/mangrove estuary interface rookeries - Alternative 4 predicts consistently higher foraging condition values than 2050 Base for all wading birds.

Southern Big Cypress marshes - Alternative 4 foraging values are consistently lower than 2050 Base for all wading birds.

Alternative 3 produced slightly better conditions in the eastern rookeries and slightly worse conditions in the Shark Slough/mangrove rookeries as compared to Alternative 4.

White-tailed Deer

Alternative 4 would slightly improve the generally poor breeding conditions for white-tailed deer in SE Big Cypress, NW ENP, Holey Land, Rotenberger, southern WCA-3A and WCA-2B as compared to the 2050 Base, particularly in years with average to above average rainfall. Alternative 4 would slightly decrease the very low breeding potential in central Shark Slough and other portions of the WCAs as compared to 2050 Base. For those few areas with high deer breeding potential (Long Pine Key and surrounding short hydroperiod marsh and NW Big Cypress), there is little difference between Alternative 4 and the 2050 Base. Overall, Alternative 4 produces slightly better deer breeding potential in Holey Land, Rotenberger and WCA-2B than Alternative 3 or Alternative 2.

Cape Sable Seaside Sparrow

On average, during the sparrow breeding season, Alternative 4 is dryer than the 2050 Base, NSM, Alternative 2 and Alternative 3. The 1995 Base and Alternative 4 produce dry conditions at about the same time and the 1995 Base re-floods the area about one week earlier than Alternative 4. For the western sparrow sub-population, Alternative 4 produced slightly improved breeding potential in the northern portions of this habitat, and slightly lower breeding potential in the southern portions as compared to the 2050 Base, with a slight net improvement for this sub-population over 2050 Base and Alternative 2. An important difference between Alternative 4 and Alternative 3 in the western sub-population area is Alternative 4's improved breeding potential in some high water years. For the core and eastern sub-populations, Alternative 4 consistently produces lower breeding potential than the 2050 Base and slightly lower breeding potential than alternatives 2 and 3. The ATLSS individual-based sparrow simulation is applied only to the western sub-population, and predicts persistence of this sub-population under Alternatives 3 and 4. A Population Viability Analysis using the individual model predicts that the western sub-population will be slightly more likely to remain above minimum numbers and reach or exceed maximum numbers under Alternative 4. Under the 2050 Base, this model consistently predicts extirpation of the western sub-population.

American Crocodile

In absence of performance measure outputs, inspection of available Florida Bay salinity outputs indicates reduced salinities under Alternative 4 that would correspond to

increased crocodile habitat suitability as compared to the 2050 Base, 1995 Base, Starting Point and Alternatives 1-2. However, Alternative 4 produces slightly higher mean salinities in many months, and slightly poorer performance for the number of times salinity criteria are exceeded than does Alternative 3.

Performance Measures and Indicators Used:

1. Breeding Potential Indices for the Cape Sable seaside sparrow and white-tailed deer.
2. Foraging Conditions index for long-legged wading birds and short-legged wading birds.
3. Fish productivity model.
4. Indicator region 46 - Cape Sable sparrow west.
5. ATLSS Cape Sable seaside sparrow Individual-based Simulation.
6. ATLSS Cape Sable seaside sparrow Population Viability Analysis

Recommendations:

1. Wading Birds - Bring down overly-deep water levels in WCA-3A and WCA-3B.

2. Cape Sable seaside sparrow - For the core habitat area east of Shark Slough, reduce dry season depths in order to preserve breeding potential in the sparrow's most stable subpopulation. For the eastern habitat areas, slightly reduce dry season depths to improve breeding potential while preserving expected beneficial effects to sparrow habitat due to reversal of shrub invasion. Decreased dry season water levels during wet years in the southeastern portion of the western sub-population area (roughly Indicator Region 7) could improve sparrow individual simulation results.

3. American Crocodile - Increase flows to Florida Bay, particularly in dry years.

Subteam Issues:

The sparrow west indicator region shows that NSM predicts longer hydroperiods in the western sub-population area that would lead to further declines in the sparrow BPI. A similar situation may exist with NSM targets for Indicator Region 8, which encompasses most of the sparrow's core sub-population. The subteam urges Restudy participants to reconsider NSM-based targets when biological information, such as sparrow breeding needs, suggests different targets.

Can the white-tailed deer BPI be combined with exiting panther radiotelemetry data to get a rough index of the proportion of the panther's prey base that is predicted to be affected by the alternatives? The subteam suspects this will prove to be a small portion of the panther's prey base, but it would be a useful calculation if it can be done before May. The subteam will work on this.

The snail kite ATLSS model was not quite finished in time for the Alternative 4 runs. It will be available for Alternative 5.

Programming for the American crocodile performance measure outputs has been completed and outputs will be available for Alternative 5.